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ABSTRACT

In the 21st century, the population will need to possess basic skills in the areas of communication and higher problem-solving as well as have scientific and technological literacy; however, results from assessments by the National Assessment of Educational Progress (NAEP) have indicated weak student performance in the area of thinking skills, making inferences from printed material, and interpreting the meaning of scientific data. The educational community has called for increased emphasis on problem-solving and higher order skills in NAEP's 1985-86 assessment. The goal of a project, as funded to investigate these thinking skills, was to develop and test a variety of measures for use in a future national assessment. Part 1 of this pilot project developed and assessed the quality and appropriateness of certain innovative tasks and procedures to measure the higher-order thinking skills used in science and mathematics. First, a conceptual framework of higher-order skills used in science and mathematics, then prototype exercises, including "hands-on" activities, were developed. Some exercises were adapted from those used successfully by the United Kingdom's Assessment of Performance Unit in England, Wales, and Northern Ireland. These efforts resulted in a set of tasks which asked the students to "think" about a variety of relationships in mathematics and science. Three categories of administrative formats were used: (1) group activities to intact classes (2) station activities consisting of "hands-on" tasks, and (3) full investigations which were administered to individual students. Almost 1,000 students in grades 3, 7, and 11 from 12 districts throughout the country participated. Scoring guides were developed, and student responses were categorized, entered into the computer, and analyzed. Results showed that students were responding to the tasks, and data conformed to expectations about basic developmental trends in thinking skills. In Part II, the pilot-tested tasks are presented individually. The group tasks are presented first, followed by the station activities, and then the individually administered full investigations. The presentation for each task consists first of the task as the students saw it; followed by directions for the administrator and the observation checklist, where these are pertinent; a description of the apparatus; the scoring guide with illustrative examples of each score level; and summary comments about the task. The data on which the comments are based included student performance on each task by grade and by sex and the correlation coefficient between the number right on the mathematics and science items and student data for most of the tasks. Separate analyses by sex were conducted to determine if there were any obvious gender biases in the tasks. No tests for significance were done on the gender results. (JAZ)

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NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

A PILOT STUDY OF HIGHER-ORDER THINKING SKILLS ASSESSMENT TECHNIQUES IN SCIENCE AND MATHEMATICS

FINAL REPORT - PART I

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
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NOVEMBER 1986

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The ideas for the majority of the exercises for this project were taken from questions constructed for the national monitoring of science performance carried out by the Assessment of Performance Unit in the U.K. We acknowledge the cooperation of the U.K. Department of Education and Science and of the unit in the Centre for Educational Studies in King's College London in making these questions available. However, the questions have been substantially changed to function with our, very different, framework so that the results will not be comparable with U.K. results. The U.K. A.P.U. is not responsible for the use we have made of their ideas.

TM 870 148

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AN OVERVIEW OF NAEP'S PILOT STUDY OF HIGHER-ORDER SKILLS ASSESSMENT TECHNIQUES IN SCIENCE AND MATHEMATICS

The planning for NAEP's 1985-86 national assessment of science and mathematics took place as public concern focused on the quality of elementary and secondary education in the United States. A number of prestigious reports critical of the schools sparked unprecedented public debate and calls for improvement across the country. For example, Educating Americans for the 21st Century, the report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, stated, "We must return to the basics, but the basics of the 21st century are not only reading, writing and arithmetic. They include communication and higher problem-solving skills, and scientific and technological literacy--the thinking tools that allow us to understand the technological world around us. These new basics are needed by all students..." It is interesting to note that much of the impetus for the national concern about weak student performance in the area of thinking skills stemmed from NAEP findings. For example, NAEP results indicated more improvement in the area of basic skills in reading, writing, mathematics, and science at the three age levels than in making inferences from printed material, solving mathematics problems, supporting hypotheses, or interpreting the meaning of scientific data. This evidence, however, was more apparent in the areas of reading and writing than in mathematics and science.

Because of this national concern, the Assessment Policy Committee, which governs NAEP and includes teachers, school superintendents, state legislators, school board members, and representatives from business and industry, called for increased emphasis on problem-solving and higher-order skills in NAEP's 1985-86 assessment of mathematics, science, computer competence, and reading. To this end, staff and consultants set out to concentrate on measuring higher-order thinking skills. However, the constraints of self-administered paper-pencil technology were limiting. Particularly in science, NAEP staff and consultants continually raised ideas based on the procedures used in the first two science assessments, when NAEP had had the resources to conduct assessments of individual students in interview situations using apparatus. It seemed that it would be difficult to gather extensive information about higher order thinking skills, without the resources to conduct an assessment using science equipment. NAEP, therefore, proposed a focused research project to the National Science Foundation to investigate higher-order thinking skills which may be used in science and mathematics and to develop innovative measures of these skills.

The goal of the project was to develop and pilot test a variety of innovative measures for use in a future national assessment. During the first phase of the project, an eleven member panel of representatives from the fields of mathematics, science, and psychology met with NAEP staff to develop a conceptual framework of higher-order skills used in science and mathematics.

The second phase, task development, began with a meeting where subject area specialists met with NAEP staff to develop prototype exercises, including "hands-on" activities in which students are asked to solve problems, conduct investigations, or respond to questions using actual materials and equipment. The development phase also included consultation with and assistance from members of the United Kingdom's Assessment of Performance Unit (APU) and their science monitoring staff at Kings College (KQC), London University, and Leeds University who have done extensive pioneering work in science assessment. Many of the exercises pilot tested in this project were adapted from those used successfully in England, Wales, and Northern Ireland, but for a different configuration of age groups and conceptual framework. NAEP greatly appreciates their invaluable cooperation.

The combined work of the NAEP panels and staff and the excellent work and guidance of the APU science team eventually resulted in a set of tasks which primarily asked students to "think" about a variety of relationships in mathematics and science. At perhaps the easiest end of the continuum, students were asked to classify and sort birds, seeds, and vertebrae according to characteristics of their own choosing.

At the next level, students were given materials, equipment, and/or apparatus which exemplified particular mathematical or scientific phenomena or relationships and were asked to observe, infer, and formulate hypotheses. For example, a rotating arm was used to demonstrate that moving weights from the ends toward the center of the arm will change the speed of the arm; tubes of sand to show the relationship between the amount of sand in a tube and the speed at which it would roll down an incline; a balance scale to show the relationship between weight and distance from the fulcrum; and a block staircase to exemplify the relationship between the height of the staircase and the total number of blocks required to build it.

Another set of tasks was designed to measure students' ability to detect patterns in data sets and interpret the results. For example, students were asked to collect and interpret data about the effect of different size and shaped wands on the number and size of soap bubbles; to collect and interpret data about the ratio of green to red gumballs in a gumball machine; and to interpret data about participants' scores on several athletic events.

At the most complex level, students were asked to design and conduct experiments examining a question posed by an administrator. These experiments included: determining if sugar cubes dissolve faster than loose sugar and if stirring makes a difference; deciding which fabric--plastic or wool-- would keep a person warmer in cold, dry weather; finding out which of several different materials would weigh the most if their volumes were equal; and using pegboards of different lengths and widths to determine how length and width affect the rate of pendulum swing. Students were given very elaborate equipment to conduct their experiments and the administrator used a checklist to record student procedures including the number and types of measurements.

Because a major part of this pilot project was to judge the feasibility of more innovative and complex assessment procedures, NAEP developed as many different prototypes of administration formats as possible. These can be classified into three major modes of administration.

Group activities were administered to intact classes. These consisted of open-ended paper and pencil tasks based on a variety of stimuli. In one case, the stimuli included a demonstration of an experiment by the exercise administrator and in the remaining tasks students were given written or tabular information. As part of the group administrations, students also were given a brief set of student background questions and a short set of either mathematics or science items from the 1986 national assessment.

Station activities consisted of "hands-on" tasks which required students to work with a set of materials and to answer questions based on them. These activities were divided into two sets of six tasks for each grade level. Groups of six students were given the tasks, with students rotating from activity to activity every eight minutes. One task in each of the sets was administered by computer. Students received directions for the activity via the computer and recorded their answers using the computer. The remaining station activities asked students to use apparatus to investigate relationships and asked them to record their findings using paper and pencil.

Full investigations were administered to individual students. The administrator posed the question, explained the equipment, and used a checklist to mark student behaviors. Students used the equipment to conduct their experiments and discussed their findings with the administrators.

Twelve school districts agreed to participate in the pilot project, and third-, seventh-, and eleventh grade students were assessed in all four regions of the country. Within each region an attempt was made to select schools in middle-income urban, disadvantaged urban, and small city areas. Twenty-two administratiors were trained during a one week period to administer the tasks and code the observational check lists for the full investigations. The pilot test was conducted during April by teams of three administrators, each burdened with over 100 pounds of equipment and apparatus. The teams spent a week in each district conducting the pilot study using one class at each grade level in each of three schools. Almost 1,000 students were assessed in all, with approximately 100-300 responses obtained for each task.

In the pilot test, every student sampled was given the group exercises. Approximately three-fourths of the students also responded to one of two sets of six station activities developed at each grade level. One-fourth participated in the individually administered investigations.

Scoring guides were developed for all open-ended tasks, and the student responses were categorized, entered into the computer, and analyzed. The results of the pilot test were shared with a panel of six advisors and the tasks were very well received. The panelists suggested revisions to some tasks, provided advice on how to refine the scoring guidelines, and commented on the many ways that the data from a national assessment of such tasks could be analyzed. For example, there was agreement that results would provide information about how students approach such problem-solving tasks, about how they think about scientific and mathematical relationships, about student profiles across tasks, and about differences in performances among various subpopulations of students. Further, performance results could be related to curriculum topics studied, instructional methods, and previous experience.

ummary

NAEP learned many things from the pilot study. Developing assessment tasks based on equipment and apparatus was much more challenging than we had anticipated. Conceptualizing and predicting the interaction between the questions, the apparatus, and the students was difficult and obtaining the equipment was inordinately time consuming.

Staff additionally had some difficulty in obtaining school cooperation, because participation required three different areas in which to set up equipment and involved pulling students from their classrooms either individually or in small groups. Recruiting and training administrators to conduct performance oriented assessments involved considerable preparation. Also, assembling the numerous and bulky pieces of equipment for shipping across the country was extremely complicated. Finally, when developing scoring guides very careful thought should be given to maximizing what is learned.

Nevertheless, staff and consultants came to the conclusion that conducting "hands-on" assessment is feasible and extremely worthwhile.

By building on the experience of the APU science team, staff was able to develop and pilot a very exciting set of tasks. These tasks not only measured a variety of thinking skills relevant to mathematics and science learning, but also covered a range of administration techniques. The schools, students, and consultants were all very enthusiastic. The students found the materials engaging and the schools and consultants were more than supportive in encouraging further use of these kinds of tasks in both instruction and assessment.

The promise of the types of new, useful information that could be obtained from a "hands-on" national assessment was perhaps the source of most enthusiasm. NAEP collected the pilot study data to assess the quality and appropriateness of the tasks rather than levels of student performance. From this perspective, the results served their purpose. They indicated that students were responding to the tasks, and in some cases, doing quite well. [illegible], the data conformed to expectations about basic developmental trends in [illegible]ing skills: 1) improved levels of performance across the three grade [illegible]s, and 2) given the grade-appropriate tasks, students appeared to have [illegible] difficulty with the sorting and classifying tasks than with determining relationships and conducting reliable experiments.

However, staff and consultants wanted to know much, much more. Questions abounded about differences in performance for subpopulations, relationships among thinking skills across tasks, the details about the approaches students used and how those affected performance, and finally the relationships between performance and previous school and home experiences. Answers to these questions would provide invaluable information about how to better foster higher-order thinking skills in today's classrooms.

* * * * * * * * * * * * * * * * * *

The project described in this report--Research on Innovative Higher Order Skill Assessment Techniques in Mathematics and Science--has been carried out by the National Assessment of Educational Progress (NAEP) with support from the National Science Foundation (NSF) through the Department of Education's Office of Educational Research and Improvement (OERI), Center for Educational Statistics.*

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Part I of this report describes the project. Part II presents the exercises pilot-tested, each with its scoring guide, sample responses, description of the equipment needed, and commentary with recommendations.

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*Prior to a reorganization of the Department of Education, this project was under the National Institute of Education (NIE).

CHAPTER 1

ASSESSMENT FRAMEWORK

1. Literature Search and First Meeting in Washington

The initial phase of the NAEP higher order skills research project was a literature search of articles and chapters in the area of problem solving and students' thinking skills. Specific emphasis was placed on students' higher order thinking as applied to problem solving in mathematics and science. The result of this search was a collection of readings that were used to familiarize NAEP staff with the current research on children's thinking and other related areas. These readings also were used to brief the advisory panel asked to help NAEP devise a conceptual framework of students' higher order thinking in mathematics and science.

Next, NAEP staff met with the OERI higher-order skills project monitor, the NAEP program officer, and NSF project sponsor to discuss conceptual and administrative issues related to the project. These issues included clarification of the research methodology discussed in the original NAEP proposal, the specific content areas to be covered in the pilot test, the conceptual models of problem solving which might be adapted as a framework for students' higher order thinking, and the potential candidates for the first advisory panel meeting.

2. First Panel Meeting

In July, 1985, an eleven member panel of representatives from the fields of mathematics, science, and psychology met with NAEP staff to develop a conceptual framework of thinking skills.

NAEP selected the panelists to include leaders in current work on the development of higher-order thinking skills in science and mathematics. They are listed below.

Louis Armijo	Naval Post Graduate School, Monterey, CA
Audrey Champagne	American Association for the Advancement of Science, Washington, DC
Randall Charles	Illinois State University, Normal, IL
Cindy Hrebar	Jefferson County Schools, Lakewood, CO
Jeremy Kilpatrick	University of Georgia, Athens, GA
Richard Mayer	University of California, Santa Barbara, CA
James Minstrell	Mercer Island High School, Mercer Island, WA
Howard R. Pollio	University of Tennessee, Knoxville, TN
James Robinson	Boulder Valley Schools, Boulder, CO
Beta Schofield	Kings College, London, England
Gerald Wheeler	Montana State University, Bozeman, MT

Additional participants included Gerald Kulm, the program officer at OERI; Richard Berry, the program director at NSF; and the project staff, Fran Blumberg, Staff Associate, NAEP; Marion Epstein, Project Coordinator, NAEP; Walter MacDonald, Science Examiner, ETS; and Ina Mullis, Associate Director, NAEP.

Several panel members gave brief presentations about their experiences and research in defining and assessing higher-order thinking. Beta Schofield's description of the pioneering work done by the Assessment Performance Unit (APU) science team in the United Kingdom was of special interest. This unit is located in and funded by the Department of Education and Science. Mrs. Schofield presented the framework the APU science teams commissioned for the work by the unit and described the APU exercises which asked students to conduct investigations.

James Minstrell presented a detailed outline of rational, creative and critical thinking skills that had been developed as part of the Washington State Guidelines for Science Education. Randall Charles and Richard Mayer presented work they had done related to mathematics education.

After much additional discussion, the consultants developed a very interactive and inclusive framework based on the premise that, at the most general level, higher order thinking skills are used to formulate a question, design and perform an analytic procedure, and reach a conclusion to a problem. Further, such thinking was considered to be continuously self-monitored and evaluated as it occurs during the course of working through a problem or situation. Finally, subject-matter knowledge, beliefs, and values also impact upon how effectively an individual employs thinking skills in a particular situation. The model, as developed, is shown in Figure 1 and the description prepared by the committee is presented below.

3. The Framework

Introduction

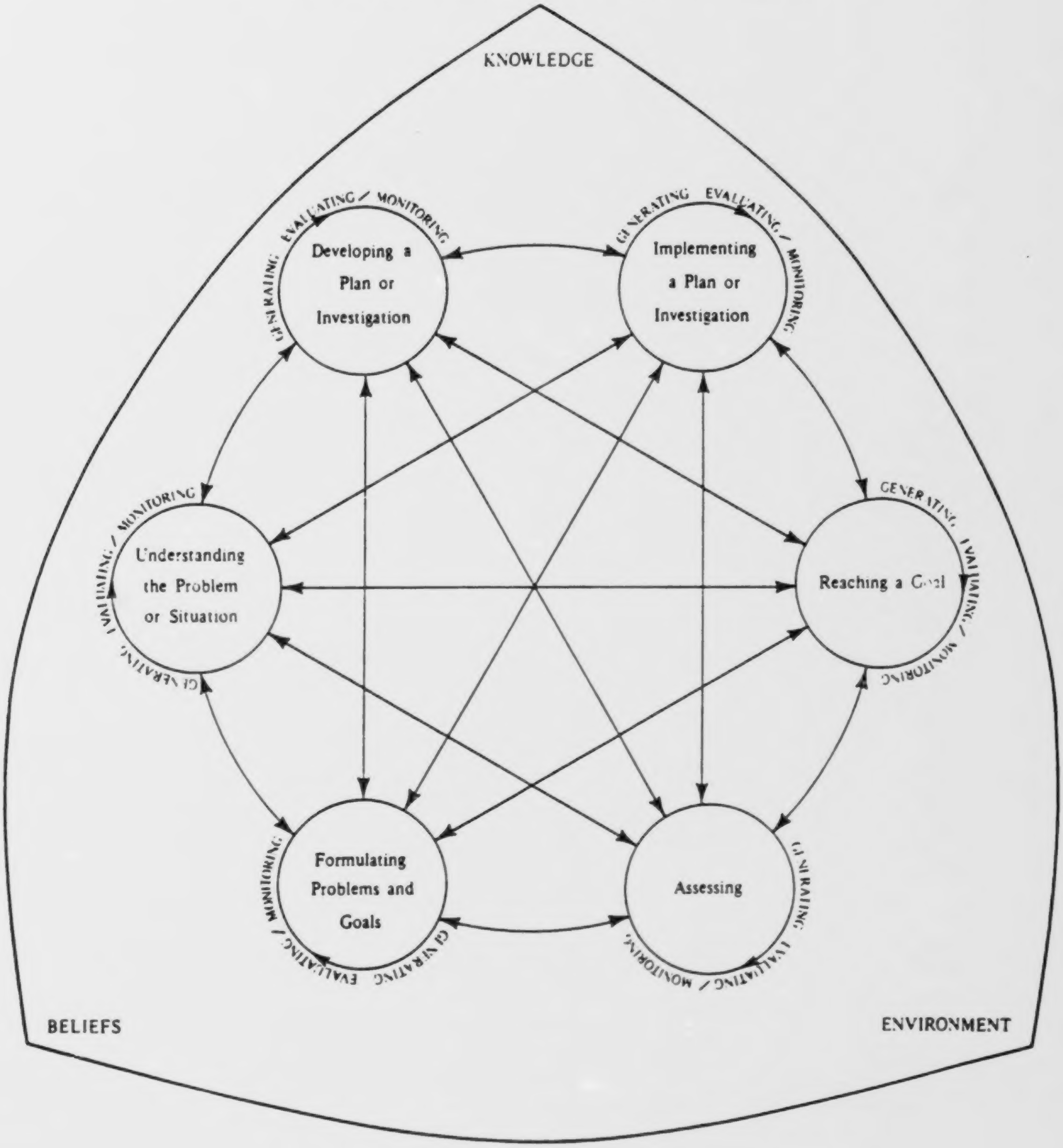
The panel organized the framework for higher-order thinking into aspects, which interact with the monitoring processes of generating and evaluating. The aspects are "snapshots" of the dynamic process of investigation or problem solving. Each is a shorthand label for a group of activities that the panel felt may be involved in higher order thinking in various situations and contexts.

The Aspects

The aspects of the model (shown in circles) are what is "done" in science and mathematics. They are not independent but collectively comprise the critical parts of the complex network of thinking skills in science and mathematics. Operating within each of the aspects are the thinking processes

FIGURE 1.

HIGHER ORDER THINKING IN SCIENCE AND MATHEMATICS


KNOWLEDGE
BELIEFS
ENVIRONMENT
Developing a Plan or Investigation
Implementing a Plan or Investigation
Understanding the Problem or Situation
Reaching a Goal
Formulating Problems and Goals
Assessing
GENERATING
EVALUATING / MONITORING

of generating and evaluating/monitoring which also are operating in the context of science and mathematics knowledge, beliefs, and the environment. The environment may include external parameters such as recent experiences, working conditions, and testing situations, as well as internal parameters such as personality characteristics and interpersonal reactions. These environmental parameters also may affect interest, motivation, attitudes, involvement, perserverance, and cooperation.

Understanding the Problem/Situation refers to initial understanding, including initial perception of the data, linguistic comprehension of the problem or situation, translation of the problem into other formats, and identification of possible outcomes. For example, the initial perception of the data may include understanding which data are relevant to the problem or situation. The linguistic comprehension of the problem may include the ability to communicate the nature of the problem to others. The translation of the problem may include the ability to look at and understand the problem in a different context. The identification of possible outcomes may include a perception of what the problem or situation mandates as well as an "a priori" estimate of the answer(s).

Develop a Plan or Investigation consists of looking for patterns, selecting and operationalizing independent and dependent variables, identifying appropriate strategies, selecting appropriate subgoals, designing data collection and organization, developing models, drawing pictures, choosing appropriate apparatus, and other similar skills.

Looking for patterns may include an initial scrutiny for trends or indication of relationships which may suggest a specific approach to investigation. Selecting and operationalizing variables also are necessary components of designing and planning an investigation. Choosing appropriate subgoals may be needed in an investigation in which there are many intermediate results that must be gained before the initial question is answered or problem is solved. Designing data collection and organization may include the planning of sampling locations, sampling frequency, and record keeping. The development of models and drawing pictures are abilities that may make the progress through a problem or investigation more efficient.

Implementing a Plan refers to the actual performance or "doing" of science or mathematics. It should be remembered that there may not be sharp boundaries between these aspects, particularly with developing and implementing a plan. For example, when carrying out an investigation, a perceived limitation in the plan may warrant redeveloping the plan. In addition, it is possible that while developing the plan, the need may be perceived for a better understanding of the problem or its reformulation. This "learning while doing" situation is an important feature of higher order thinking in science and mathematics.

Reaching a Goal, dependent upon the original problem or situation, may include such activities as; determining the answer, drawing conclusions, and reaching a decision. The ability to determine the answer may include the discarding of extraneous solutions or the recognition of multiple solutions when they exist. Drawing conclusions may include the ability to interpret results, recognize their implications, and knowing when the desired outcomes have been achieved. This is similar to the ability to recognize when adequate information has been obtained when reaching a decision was the initial goal.

Assessing is an overall evaluation of the investigation performance or problem-solving rather than the ongoing evaluation and monitoring. Inherent in this aspect are many skills such as reflecting, interpreting results, generalizing, anticipating, and reporting the findings.

Reflecting includes looking back on the entire body of work and checking. The checking component of reflecting is the verification of the precise execution of the original plan and may include repeating some or all steps of the problem or investigation, or a review of the process or calculations. Looking back may include assessing the reasonableness of the results and determining whether the original problem or situation has really been answered. Interpreting results may include noting whether there have been any unexpected and valuable findings, and determining the significance of the results. Generalizing may include the ability to recognize patterns in data or results, to apply them to more complex or different situations, and to formulate general theories from specific results. Anticipating, based on the results or generalizations from results, may include looking ahead, predicting, and recognizing implications for future investigations.

Formulating Problems or Goals includes detailed, precise observations of facts or results and the initial formulation of hypotheses. For example, the identification of a pattern or the prediction done while assessing may lead to the formulation of a new hypothesis for investigation. Raw data or a set of personal observations also may lead to the formulation of a problem or the setting of a goal without being influenced by a prior investigation.

Again, the entire process is dynamic and the distinctions between the aspects are fuzzy. Reaching a goal, assessing, and formulating goals will often blend with each other and problem solving or investigations may require repeated iterations. Operating within each of these aspects are the generating and evaluating/monitoring processes. A description of each of these processes is presented next.

The Generating Processes

Central to and permeating all aspects of higher order thinking is the ability of the individual to produce novel ideas, situations, approaches, and possibilities.

There are many ways in which this may happen; historically these ways have been split into two major divisions - analytic and intuitive. Included under the analytic category may be inductive and deductive reasoning, hypothesis formation, formal modeling, correlating variables, inferring relationships, and synthesizing observations into concepts. Included in the intuitive category may be the use of analogy, metaphor, and other non-literal devices; inexact, qualitative approximation; and imagery (many models originate from images).

In actual practice, the distinction between the modes are nebulous and the individual may operate in both modes simultaneously. For example, discerning a pattern or generalizing observations into new concepts may include both intuitive and more formal, analytical techniques.

The Evaluating Processes

Evaluating and monitoring are the quality control operations for higher order cognitive processes. The evaluating/monitoring processes function as sentinels that check progress through a plan. Have I executed all the elements of my plan? How do I determine when it makes sense to give up on a problem or to go to get help from someone else? When do I need to get the opinion of a peer or teacher on my progress?

Evaluating/monitoring also implies the existence of a standard against which each product of the processes of problem solving is matched. Standards are internal and external. External standards for scientific and mathematical problem solving are discipline specific. They are derived from subject areas and, thus, there is a need for a strong base of organized content knowledge. Internal standards are set by the individual's beliefs.

Therefore, it is with the processes of evaluating/monitoring that the aspects as well as the generating processes of higher order thinking are controlled and directed. For example, the interaction of evaluating/monitoring with the generating process is extremely important in winnowing ideas that are too fanciful and the interaction of evaluating/monitoring with the various aspects is also important in winnowing unrealistic activities.

CHAPTER 2

EXERCISE DEVELOPMENT

1. Second Panel Meeting

A seven person panel met to develop prototype tasks and to consider potential assessment strategies, methods of administration, and how the exercises should be scored. To provide continuity, four members of the original panel participated in the meeting--Jeremy Kilpatrick, Richard Mayer, James Minstrell, and James Robinson. To provide additional perspectives, NAEP also invited Roberta Flexer, University of Colorado, Boulder, Colorado; Josephine Davis, Albany State College, Albany, Georgia; and Patricia Murphy, Deputy Director of the APU science team at King's College, London, England. (The NAEP staff and the representatives from OERI and NSF were the same as for the first panel meeting.)

Panel members shared ideas on innovative activities for third-, seventh-, and eleventh-grade students, including those which would require students to plan and carry out full problem solving investigations. Many useful ideas for assessment activities using contexts in mathematics and science were suggested.

Patricia Murphy contributed many significant comments, caveats, and suggestions based on her extensive experience with the APU science assessment over a number of years. The points she made which had a major impact on exercise development included:

- In developing assessment exercises in mathematics and science contexts, it is necessary to take into consideration external influences which may create gender effects, influence motivation, or affect students' willingness to complete a given task. For example, APU found that female-stereotyped activities, such as determining the most effective flooring for a kitchen, did not engage some of the boys in their sample.
- Because students' views of what is or is not "science" are shaped by their experiences, they may reformulate a given assessment task to fit their perception of science and proceed to solve the problem in ways incompatible with those intended by the assessor. This can have serious implications for the scoring, analyzing, and reporting of student performance. (The APU science teams chose to use open items to derive a rich source of children's perceptions of, and reactions to, science tasks. Categories of response were developed to deal with the data obtained from these items. The categories included typical hierarchies of response but in addition included alternative but equally adequate responses as well as a variety of error responses. Categories of response with these attributes are not readily scaleable. Consequently, this type of analysis is incompatible with a goal to report results in a predetermined way. If this is the priority, then uniformity in students' conceptualization of the problem is needed to analyze and report results in a standard way across the sample of respondents, and the goal, when developing exercises, should be to use contexts which are common enough to be understandable yet unfamiliar to the extent that students do not have a learned algorithm available to solve the problem.)

- APU has found that students are better at actually performing an investigation to solve a problem than they are at explaining, verbally, the operations involved in an investigation. Accordingly, there should be awareness when designing an assessment that students' performance may be better on less structured "hands-on" assessment methods than on more structured paper and pencil and interview methods.
- Whenever possible, the method of administration of the activities should be consistent across all age groups to permit better assessment of developmental change in problem-solving and to get a better perspective on which types of activities are or are not suitable for a given age group.

A major issue discussed throughout the meeting was the confounding of subject-matter background knowledge with the ability to solve a given problem. Consequently, in developing tasks, staff and consultants decided to try to minimize the potential effect of prior knowledge on successful performance.

The panel split into two groups for exercise development, one with an emphasis on mathematics, the other on science. Each group was responsible for developing ideas for innovative exercises within their area of emphasis as well as some that integrated or incorporated concepts from both areas. At the conclusion of the meeting, the ideas for assessment activities developed were reviewed and evaluated with particular attention given to administrative feasibility, administrator training, and equipment needed.

All those participating in this development process were impressed by the difficulties involved and were concerned about the short time frame for the project. It was agreed that it would be desirable to try and benefit more fully from the higher order skills activities and administration procedures developed by the APU science team.

2. The Assessment Performance Unit (APU): Science

As stated previously, NAEP had invited a representative from the APU science monitoring team to each of the planning conferences. From the descriptions of the work done by the APU provided by these representatives and previous visits between NAEP and APU staff members, it became apparent that the project planned by NAEP had aspects in common with parts of the APU science assessment.

As shown below in Table 1, which presents the category descriptions for the APU Science Assessment Framework, three of the categories are measured using "hands-on" or practical assessment techniques. These three are: Category 2--Use of apparatus and measuring instruments, Category 3--Observation, and Category 6--Performance of investigations.

Since the APU had seven years experience in developing and assessing performance tasks similar to those envisioned by the NAEP staff and consultants, a visit to the APU to see their assessment materials seemed very appropriate. The staff of the APU was more than gracious in preparing for our visit, having set up a basketball gymnasium full of their performance tasks. On display, were the questions, administration directions when appropriate, complete sets of the apparatus, and scoring guides. NAEP staff were left to "self-administer" the many hands-on tasks and the APU staff were available for questions.

Table 1.

The APU Science Assessment Framework*
The Categories of Science Performance

Category	Sub-categories	Mode of Testing
1 Use of graphical and symbolic representation	- reading information from graphs, tables and charts - representing information as graphs, tables and charts	written tests
2 Use of apparatus and measuring instruments	- using measuring instruments - estimating physical quantities - following instructions for practical work	practical tests
3 Observation	- making and interpreting observations	practical tests
4 Interpretation and application	- I interpreting presented information - II applying: biology concepts physics concepts chemistry concepts	written tests
5 Planning of investigations	- planning parts of investigations - planning entire investigations	written tests
6 Performance of investigations	- performing entire investigations	individual-practical tests

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*Science in Schools, Ages 13 and 15: Report No. 3, Assessment of Performance Unit, Department of Education and Science, ©. Crown copyright 1985.

NAEP staff were very experienced in test development, yet in the week spent working through the APU materials, the overwhelming nature of developing and assessing materials of such quality and complexity became clear. It became apparent that NAEP was not going to be able to develop more than a relatively small portion of such tasks in the short time proposed for the higher order skills project. Designing the apparatus alone would be a monumental task. Thus, NAEP entered into an arrangement for further support from the APU for both consultant help and use of some of their copyrighted materials. This arrangement enabled NAEP to benefit from some already validated materials for use in piloting these tasks in American schools, and to focus on developing new exercises such as those involving computers and those assessing higher order skills in mathematical contexts.

Some difficulties did arise because of a certain dissonance between the goals of the APU Science Assessment and NAEP's higher-order skills assessment project. First, the APU routinely conducts their science assessment based on all six categories shown above in an integrated way. Unfortunately, because of lack of resources, NAEP has not been able to conduct a science assessment that included hands-on work with apparatus since the second assessment conducted in 1972-73. NAEP simply did not have the resources to include these types of items in the regularly scheduled science assessment conducted in 1985-86 and was working on such tasks separately, rather than in the context of the full science assessment. In fact, this omission in our more recent science assessments was an impetus to the project proposal. Second, NAEP had received a mandate from its governing body, the Assessment Policy Committee, to focus on the assessment of higher-order skills in both the 1985-86 mathematics and science assessments. This had proved somewhat difficult using paper and pencil technology within the restraints of the overall research design and resource limitations. The APU science team was using hands-on performance tasks to measure specific science skills as described in their assessment framework. For NAEP, the emphasis needed to be on the thinking skills involved as opposed to science content, although the two are not independent.

However, it should be noted that both the NAEP and APU science assessment frameworks emphasize skills as well as content. A spectrum of skills, from basic to higher order ones, is reflected in the APU science categories 1 to 6 (Table 1). This spectrum of skills forms the central theme of the whole national monitoring program in science in the United Kingdom. In the APU science assessment where the emphasis in the tasks is on the assessment of skills, content is used as a vehicle for their deployment. There is no requirement in these tasks for the pupils to explain the influence of the content. The assessment of children's understanding of scientific knowledge is done in Category 4ii of the Assessment Framework (Table 1). In this category, pupils have to recall, apply and explain their conceptual understanding.

After further discussion, it was resolved that NAEP could revise and modify materials developed by the APU for their Category 3--Observation, but that NAEP would try to replicate any Category 6--Performance of Investigations materials as faithfully as possible within the constraints of our time and resources. NAEP is grateful for the continuing support of the APU science monitoring team throughout the many phases of this pilot project.

3. Internal Development

After the exercise development panel meeting, staff sent copies of the framework to mathematics and science examiners within ETS and requested additional suggestions for innovative tasks to assess higher-order skills in these disciplines. At the same time, staff began intensive review of the panel's suggestions for activities and of the more fully specified tasks.

It was decided that the pilot testing should include three types of administrations - paper and pencil tasks that could be administered in a group setting; short, self-administered "hands-on" tasks with several activities set-up at stations in a room and students conducting the activities on a rotating basis; and full investigations administered to individual students. Although the panel had been especially interested in the full investigations, the staff recognized that the project could not afford testing more than two or three full investigations at each grade. Therefore, some of the tasks developed by the panel were converted to station exercises. Some additional exercises were developed by the staff and tasks proposed by the panel were fleshed out and refined. In some cases, tasks had to be discarded because the equipment required would be too complex.

The project staff considered all the available tasks, including those newly developed and a selected subset of those developed by the APU science team. They identified those newly developed exercises that could be converted to group administration, selected the full investigations for individual administration, and made an initial selection of more than enough station activities for two sets of six stations for each grade.

A concentrated period of reviewing and revising the selected tasks followed. Given the time frame for the project, there would have been difficulties in meeting the schedule for federal agency reviews of the tasks, printing the booklets, training administrators, and carrying out the pilot testing without the invaluable cooperation of the APU science team. The ideas for more than half the tasks were taken from exercises developed by the APU for their national monitoring of science performance. However, many of these exercises were substantially changed to function with NAEP's very different framework and it should be noted that the APU is not responsible for the altered use of their ideas in this project. Five group exercises, six station activities, and one full investigation were completely developed by NAEP staff.

The exercise development panel had recommended administering some of the mathematical exercises by computer. They suggested that students could estimate the ratio of red to green gumballs based on repeated drawings from a gumball machine and that students could work number games appropriate to their age level similar to the mathematical game of "Nim." Scripts were written for the two exercises at grade 3 and two similar tasks for grades 7 and 11. Programs were written for Apple II series computers because more schools have these than any other type of computer. NAEP and ETS staff set the specifications and wrote the BASIC computer coding for these programs. Programs were reviewed, tried out, and further revised.

4. The Tasks for the Pilot Study

The combined work of the NAEP panels, ETS staff, and the excellent materials and guidance provided by the APU science team eventually led the project staff to select a set of tasks which primarily asked students to "think" about a variety of relationships in mathematics and science. At perhaps the least difficult end of the continuum, the tasks asked students to classify and sort birds, seeds, and vertebrae according to characteristics of their own choosing. While biologists have given such schemes much thought and it was hoped students might think like biologists, the goal was to assess flexibility and an ability to think of alternative ways of sorting or classifying.

At the next level, the tasks were based on materials, equipment, and/or apparatus which exemplified particular known mathematical or scientific phenomena or relationships. The students were asked to work with the equipment and observe, infer, and formulate hypotheses. For example, the whirlybird apparatus was used to demonstrate that moving weights from the ends toward the center of the arm will change the speed of the whirlybird arm; tubes with sand were used to show the relationship between the amount of sand in a tube and the speed at which it would roll down an incline; a "wig-wag" apparatus to show the relationship between the amount of weight placed in a flexible tray and the speed and amplitude of its swing; and a double staircase of blocks to exemplify the relationship between the height of the staircase and the total number of blocks required to build it.

Another set of tasks was designed to measure students' ability to detect patterns in data sets and interpret the results. For example, students were asked to collect and interpret data about the effect of different size and shaped wands on the number and size of soap bubbles; to collect and interpret data about the ratio of green to red gumballs in a gumball machine; and to interpret data about participants' scores on several athletic events.

Finally, individual students were asked to conduct full investigations. In Sugar Cubes they were asked to determine if sugar cubes dissolve faster than loose sugar and if stirring makes a difference. Survival required them to determine which fabric--plastic or wool--would keep a person warmer in cold, dry weather. Density asked them to determine which of three materials of different size and shape would weigh the most if their volumes were equal.

In Pegboards, students were asked to use boards of different lengths and widths to determine how length and width affect the rate of pendulum swing. For these tasks, observers marked student behaviors on a checklist.

The tasks by thinking skill and administration type are listed in Table 2. All the pilot-tested tasks appear in Part II of this report exactly as they were presented to the students, with their scoring guides, sample responses, description of the apparatus, summary comments, and pilot-test data. In addition, a brief set of student background questions was devised so that the pilot-test sample could be described. These, along with the results, are included in Appendix B. For linking and research purposes, at each grade level a small set of about 20 items each of science and mathematics exercises from NAEP's spring 1986 national assessment was selected to be part of the pilot administrations. (These items are secure.)

5. Obtaining the Apparatus and Equipment

The majority of the exercises developed for the project were "hands-on" and required the use of apparatus and equipment. These materials were either purchased from supply houses or devised by NAEP and ETS staff.

During the October visit to the APU science team at Kings College (KQC), London, NAEP staff learned that the APU Science team worked with Philip Harris Ltd. and this company was contracted to assemble, package, and ship selected materials based on APU specifications. The equipment that arrived at NAEP early in March included multiple sets of each of the following: Whirlybird (a group exercise); Sand and Tubes, Rolling Funnels, Wig-Wag, Water-on-Brick, Bubbles, Tubes and Capillarity, Conductivity, Magnet and Compass, and Sugar Cubes (station exercises); Sugar Cubes, Pegboards, and Survival (full investigation exercises). (The apparatus for Sugar Cubes as a station exercise for grade 7 is the same as for the full investigation for grade 3.) Pictures of the apparatus are included in Part II of this report.

Table 2.

NAEP Pilot Study Thinking/Inferencing Skills by Administration Type

	Administration Types		
Thinking/Inferencing Skills	Group	Station	Individual
Sorting, Classifying (distinguishing patterns within a single class of items)		Birds (classify) (3) Birds (sort) (3) Seeds (classify) (3,7,11) Vertebrae (sort) (11) Seeds (sort) (7)	
Observing, Inferencing, and Formulating Hypotheses based on mathematical and scientific principles (inferring relationships between an independent and dependent variable)	Whirlybird (3,7) Number Relationships (7,11) Restaurant (7,11)	Sand and Tubes (3,7,11) Rolling Funnels (3,7,11) Circle Game (3) Number Game (7,11) Wig-Wag (3,7) Water on Brick (3) Balance Scale (7,11) Double Staircase (3,7,11) Tubes and Capillarity (7,11) Conductivity (11)	
Interpreting data (inferring patterns in results)	Hair Color (3) Triathlon (3,7,11)	Gumball Game (3,7,11) Bubbles (3,7,11) Magnet and Compass (11)	
Designing and Conducting an experiment	Heart Rate and Exercise (11) (designing only)	Sugar Cubes (7) Magnets (3)	Sugar Cubes (3) Pegboards (3,7,11) Survival (7,11) Density (7,11)

NAEP and ETS staff devised the materials and apparatus for the other station exercises: Gumballs, Circle Game, Numbers Game, Balance Scale, Double Staircase, Magnets, Birds (classify), Birds (sort), Seeds (classify), Seeds (sort), and Vertebrae, and for the other full investigation exercise, Density.

Gumballs, Circle Game, and Numbers Game were the station exercises developed for self-administration using an Apple II computer. Twelve operational and 12 back-up disks were prepared for each program at each grade level.

For Balance Scale, the scale was designed and made at ETS. The unknown weight was a plastic film canister filled with gravel. For Double Staircase, stock lumber was purchased, hundreds of wooden blocks were cut, and double staircases were assembled.

For Magnets, disk magnets were purchased at Edmund Scientific Co, Barrington, NJ. Eight disk magnets were glued together to make strong magnets whereas non-magnetic washers were sandwiched between two disk magnets to make weak magnets. Both types of magnets were dipped in paint to give a uniform external appearance.

For Birds (sort), small, colored drawings of seven species of small, perching birds were purchased and mounted on cardboard. For Birds (classify), colored photographs of four species of waterfowl were acquired and mounted on cardboard. The seeds selected for Seeds (sort) and Seeds (classify) included caraway, cumin, fennel, black peppercorns, all spice, white peppercorns, millet, yellow mustard, and fenugreek. All of the seeds were purchased at a local food store.

For Vertebrae, four cervical, three thoracic, and four lumbar vertebrae comprised each set of bones. The bones were ordered from Connecticut Valley Biological Supply Co. in Holyoke, MA.

Density required three blocks of different shapes and sizes, made of woods with significantly different densities. NAEP staff acquired the woods, cut them to size and shape and painted them for external uniformity. A scale was purchased from Edmund Scientific for weighing blocks. Rulers and solar calculators were purchased for measuring volumes and calculating results.

Utility kits and ancillary materials were provided for the administrators to assess, to repair, and to refurbish all exercises. All the equipment and ancillary materials are listed in Appendix A.

Developing and acquiring the apparatus and equipment for this project consumed far more time and resources than had been anticipated. Because of the novelty and innovativeness of these exercises, a trial and error approach was applied to their development. There were many "brain storming" sessions to devise adequate designs for the apparatus. These sessions were often followed by many "scavenger-hunt" days to find suitable materials. An aspect which had to be carefully considered during this project concerned the packaging and shipping of the exercises. Restraint was exercised to control the size and weight of the equipment for individual exercises in order to contain shipping costs and keep the materials manageable for administrators.

6. Development of the Scoring Guides

All the tasks were developed with corresponding scoring guides. Because many of the exercises were adapted from the APU science project, some of the scoring guides also were based on the guides provided by the APU science team.

Most of the tasks had more than one part and each part was scored separately. Student responses to some parts were simply scored correct or incorrect; for example, the right number of blocks of the staircase or the correct mathematical equation. Other parts were scored using a continuum which took into account correctness, completeness, and level of cognitive sophistication. For example, the relationship between the amount of sand in the tubes and the speed the tubes rolled down the incline could have been erroneously stated, partially stated, or completely and accurately stated.

All scoring guides, including those modeled after the APU, were developed over the course of several stages of review and refinement. NAEP and ETS staff reviewed and revised the guides as did members of the APU science team. Attention was paid to the recommendations made by the APU science team; nevertheless, the changes made to the original APU items and scoring guides meant that the final results for the group and station exercises were quite different. The final stage of scoring guide development involved revisions based on actual student responses to the exercises. Because we were unable to predict the complete range of student responses before the administration, the final revisions helped the guides better represent those responses students gave during the field test.

7. OMB Clearance

As a federally funded agency responsible to OERI, NAEP is responsible for submitting all field test materials to OERI and to the Office of Management and Budget (OMB) for clearance.

In fulfillment of this obligation, NAEP prepared a clearance package for review in early December, 1985. This package consisted of a copy of all pilot-test exercises, including the NAEP mathematics and science blocks, a justification for the higher-order skills project, and an outline of the pilot-test methodology and analyses to be conducted.

Upon receipt of the clearance package, OERI staff conducted an initial review of the tasks and made many suggestions for revising and reformatting the exercises. Because of the extensiveness of the suggestions, a meeting was scheduled in Washington between the OERI project monitor and a member of the NAEP staff working on the project to discuss the suggested changes and make the necessary revisions.

Clearance was obtained from OMB in March, 1986.

CHAPTER 3

PILOT TESTING

1. The Design

The design for administering the pilot study took into account the fact that the project's requirements placed heavy demands on the time and facilities of cooperating school districts and on the time of participating students. The essential elements of the plan were:

- To minimize travel costs, each participating district was asked to make available one class of students at each of the three grade levels.
- All classes in the sample participated in a half-hour administration consisting of a brief set of background questions, a 14-minute set of either mathematics or science exercises from NAEP's 1986 national assessment, and 15 minutes of newly developed paper-and-pencil free-response exercises. These booklets were spiralled in each district: every other student was given a booklet with the mathematics items, and every other student a booklet with science items.
- All students in the sample either participated in full investigations on a one-to-one basis with an administrator or in station activities in a group of six students. All of the individually administered full investigations were pilot tested in all districts. The two investigations for grade 3 were given to the same students in one 55 minute session. NAEP administered the same three investigations at both grades 7 and 11. Some students were given two investigations in one 55 minute session while others were administered a single longer investigation in a similar time frame. (The APU administration allowed the same average time for each investigation and the same number to be completed by each student.)

- To conduct the station administrations, six stations were to be set up around a room and students worked on each activity for eight minutes before being rotated to the next station. In each district, the goal was to administer the station activities to at least three sets of six students at each grade.
- Because of the large amount of equipment required for the stations the station activities were divided into two sets, A and B, with the sets balanced to assess similar skills. Only one of the sets was administered in a given district.

All the exercises pilot-tested are shown in Table 3 by administration type and by grade level.

Table 3.

Pilot-Test Tasks by Administration Type and Grade Level

Group Exercises

Grade 3	Grade 7	Grade 11
1. Whirlybird*	1. Whirlybird*	1. Triathlon
2. Hair Color	2. Triathlon	2. Number Relationships
3. Triathlon	3. Number Relationships	3. Restaurant
	4. Restaurant	4. Heart Rate and Exercise

*Demonstrated by an administrator

Station Activities

A Stations

Station	Grade 3	Grade 7	Grade 11
1	Gumballs, Grade 3*	Gumballs, Grade 7, 11*	Gumballs, Grade 7, 11*
2	Sand and Tubes	Sand and Tubes	Sand and Tubes
3	Birds (classify)	Seeds (classify)	Seeds (classify)
4	Bubbles	Bubbles	Bubbles
5	Double Staircase	Double Staircase	Double Staircase
6	Water on Brick	Sugar Cubes	Magnet and Compass

B Stations

Station	Grade 3	Grade 7	Grade 11
1	Circle Game*	Number Game*	Number Game*
2	Rolling Funnels	Rolling Funnels	Rolling Funnels
3	Birds (sort)	Seeds (sort)	Vertebrae
4	Magnets	Wig-Wag	Conductivity
5	Wig-Wag	Tubes and Capillarity	Tubes and Capillarity
6	Seeds (classify)	Balance Scale	Balance Scale

*Administered on Apple II series computers.

Full Investigations

Grade 3	Grades 7 and 11
Pegboards (30 minutes)	Pegboards (30 minutes)
Sugar Cubes (25 minutes)	Density (25 minutes)
	Survival (55 minutes)

2. Obtaining the Sample

The first phase of pilot testing involved selecting testing sites. These sites were drawn from districts in each of four regions: Northeast, Southeast, Central, and West. Within each of these regions, districts were selected from middle-income urban, disadvantaged urban, and small city areas. The only stipulation placed on the selection was that a school district not be part of the NAEP 1985-86 national assessment sample. Initially, 48 school districts were identified, 12 for each national region. Within the 12, four districts were representative of each of the three sizes and types of community. An additional check was made with the QED School Guide for 1985-86 to ensure that each of the selected districts had access to Apple II or Apple II compatible computers which were necessary for some of the station activities.

The initial contact within a district was made with the school superintendent by telephone. Staff gave the superintendent a brief overview of the project, discussed the goals of the pilot test, and explained the various requisites for participation. All interested superintendents were sent more detailed information about the project and the pilot testing. These superintendents then were contacted again, and, if willing to participate in the project, were asked to designate a person to help schedule the school administrations. Each district was asked to provide three classes of students; one each at third, seventh, and eleventh grade. NAEP also asked that the class size be about 24-30 students and that the classes be drawn from the general school population (i.e., not an honors class or special education class).

The third contact in each district was frequently made with the Director of Research within the district, or in a few cases, with the principals of the schools selected for pilot testing. If it was the research director, staff requested the names of the principals of the schools selected and also asked which week within a specified four-week period would be most convenient for pilot testing. All testing for this project was conducted between March 17 - April 11, 1986.

The final contact was made with the principals of each of the participating schools to determine which days of the selected week would be most convenient for testing. All schools were told that testing would last up to a day and a half.

Because of the relatively short time available for advance notice and the complexity of the project, obtaining cooperation was difficult. Yet, 12 districts were secured for the pilot test. These districts represented each of the four regions and the three types of communities within all bu [illegible] f those regions.

3. Recruiting and Training Administrators

In preparing to train administrators for the pilot study, project staff combined NAEP procedures and APU procedures. The APU used practicing science teachers to administer the "hands-on" tests. This was seen to be particularly important as the administrators had to be able to distinguish what was significant and relevant about pupils' actions. Furthermore, the training of the administrators was intensive and was restricted to only one or two investigations at most and a single category test. NAEP, on the other hand, has a tradition of hiring and training administrators to minimize the burden on the schools. However, we did conduct as intensive a training session as possible and restricted the responsibilities of the administrators to a reasonable number of tasks. NAEP and APU science team staff trained 22 administrators to conduct the pilot test. Fourteen of these administrators were recruited through an agency which advertised for temporary research assistants with backgrounds in primary and/or secondary mathematics, science education, or experience with children. The applicants selected for interviews were all college graduates with experience in either mathematics, science, or related areas. The remaining eight administrators were drawn from NAEP and ETS staff.

NAEP trained the administrators in a five-day session held during the week prior to pilot testing. The APU Deputy Project Director, who had come from London to assist in the training, had many fine points to improve the structure and administration of the session. The first day for all administrators was dedicated to an overview of NAEP, the higher-order skills project, and the administration of the group activities. After the first day, the session was designed so that half of the week was devoted to training on the station exercises and the remainder of the week was devoted to training on the full investigations. Eight of the administrators were trained during the first half of the week on the station exercises. The fourteen administrators recruited through the agency were trained during the later half of the week on the full investigations. The goal was to have administrators specialize in one specific type of field test activity so that it would be administered as reliably as possible. For example, within the full investigations, half of the fourteen administrators were trained on two full investigations (Sugar Cubes and Survival) and the remaining seven investigators were trained on three full investigations (Sugar Cubes, Pegboard, and Density).

Staff developed an administration manual for use by the administrators during the training. Later, the manual was used for reference in the field.

4. Shipping and Administration

All bulky materials, including the station equipment, full investigation equipment, and the test booklets, were shipped from ETS to the first testing site in each district. The administrators were responsible for hand-carrying the small or fragile materials for a few exercises and for copies of the full investigation scripts and checklists. Once the shipped materials had arrived in a district, the administrators were responsible for transporting the materials from site to site. All shipped materials were sent back to ETS at the conclusion of testing in each district.

Three administrators were responsible for all pilot-test activities within a district. One administrator was responsible for the group exercises and two or three full investigations, one for the other full investigations only, and one for the station activities only. The group exercises were administered first in each school. These exercises were given to students in their classrooms. While the group exercises were administered, the other two administrators were responsible for setting up equipment in the three testing areas predesignated by the school principals. The administrator responsible for the station exercises set up the six individual stations in one large testing area. The administrator responsible for the full investigations set up that necessary equipment in each of the two smaller areas.

Before the group administration, each student was assigned an identifying code indicating grade, district, and number within grade and was instructed to enter this code on all booklets and response sheets used. Following the group administration, groups of eight students were released from their classrooms and sent to one of the three testing areas. Six students were assigned to the station exercises in the large testing area. The remaining two students were each sent to one of the other two testing areas and asked to complete either one or two full investigations. For each investigation, the administrator presented the problem and recorded the student's actions on a behavioral checklist while the student worked. Immediately following the investigation, the administrator asked questions which probed the student's understanding of the problem and his/her findings.

All students then returned to their classrooms and the next group of eight was sent to the testing areas. After the last set of students was assessed, the administrators packed up the equipment, collected the booklets, and prepared for the next testing site.

All school principals and other designated school personnel were thanked at the conclusion of the testing in their school. Many of the school staff were interested in the project and eager to discuss it with the administrators. Letters of appreciation also were sent to the district superintendent and to all the individual schools after the pilot testing was over.

5. Debriefing the Administrators

About one month after the last week of testing, NAEP invited the administrators for a debriefing session. The purpose of the meeting was to discuss the administrators' experiences during the pilot study. The following topics were discussed: 1) the administrators' impressions of how well the exercises worked as judged by the students' understanding and involvement in the task, and 2) how the logistics of the activities and equipment influenced the efficiency of the pilot test. A form, which the administrators were to fill out and return to NAEP, considered the logistical issues in more detail. This form was based on one that was originally used by the APU science team for their debriefing sessions.

During the two and one-half hour discussion, the administrators provided specifics about the efficacy of the various exercises and how they might be revised for future use. For example, in discussing the group exercises the administrators reported that the vocabulary tended to be too difficult for the third grade students. They reported that the younger students also had difficulty understanding some of the tasks, particularly the Whirlybird which was originally used with older children in the APU science sample.

For the station exercises, the administrators reported no problems in moving the students from station to station. However, they did report that not all exercises required eight minutes and that students had difficulty understanding the resources for Seeds (sort) (grade 7) and Birds (sort) (grade 3). Although students at all grades enjoyed the computer exercises, many of the students were unable to complete the exercises in the allotted time. The administrators also noted a lack of clarity in the instructions for a few of the exercises. Finally, they made several good suggestions about the equipment: improve the hooks on the balance scale and provide plastic rather than glass equipment. (If glass equipment is used, be sure to provide replacement beakers and tubes.)

When discussing the full investigations, the administrators noted that many of the younger students had difficulty with the concepts used in the problems (i.e., "dissolving" in Sugar Cubes at grade 3). In a few instances, the younger students only used those behaviors demonstrated by the administrator during the problem introduction. Also, some third-grade students had difficulty completing the response sheets. An additional issue raised concerned the appropriateness of prompting students when they appeared to be at standstill in conducting the full investigations. The APU has administered the investigations in two ways, with and without a set of scripted, structured prompts. NAEP decided not to have prompts; but, in the pilot study some administrators prompted the students into working on the investigations after an unusually long pause in work or when a student was unclear about the task. This seemed much less awkward and it was suggested that a standardized prompt be included in the administrator's scripts in future assessments.

The administrators also discussed the effectiveness of the training materials. The administrators noted that they would have appreciated more dry runs in the training and some "dress rehearsals" with children, if possible. The APU training sessions for the full investigations involved the administrators in coding checklists while observing video tapes of pupils and finally with actual pupils. The reliability of the administrators was determined during the training session. It was found essential to provide administrators with lists of typical coding errors so that they could check on their own consistency while in the field. In addition all checklists were checked by APU personnel for internal consistency prior to being put on the computer. The checklists were designed to make administrator errors obvious.

Topics that were briefly covered included the educational caliber of students in the field test, the unrepresentative classes provided in two schools, and how to improve communications with the individual schools prior to testing.

In general, the administrators reported that most of the students were highly motivated and willing to participate and that the schools were very interested in the project.

CHAPTER 4

ANALYZING THE DATA

1. Scoring and Data Entry

A. Scoring

NAEP and ETS staff members scored the student responses. A training session was held to ensure that all scorers were in agreement about the definition of each score point. Involved staff discussed the scoring guides for each of the exercises and how they should be applied to student responses. Sample papers were used to familiarize scorers with the types of student responses to each of the different questions. To conduct reliable scoring, scorers reviewed samples until achieving consensus on each score point.

Scorers were responsible for placing their assigned scores in the test booklets beside the student responses. For the computer administered exercises, the printout of the student responses was scored in the same way. Because the score ranges were different across exercises and exercise parts and because NAEP was most interested in the cognitive skills demonstrated by the particular exercise parts, total scores were not provided for multi-part exercises. Reliability was monitored by having project staff periodically review scored booklets.

All scoring was completed in approximately three weeks.

B. Data Entry and Organization

Staff began scoring, organizing, and entering the data while actual administration of the assessment was still underway, with this activity continuing until several weeks after data collection had been completed. Data entry was divided into three principal tasks. The first involved organizing the data into a format that would both facilitate the data analysis and minimize storage costs by avoiding excessive redundancy. With this in mind, the data was divided among twelve files containing the following information:

1)	HOSCODES	Information about which activities were completed by each student;
2)	HOSMA3	Grade 3 mathematics and group data;
3)	HOSMA7	Grade 7 mathematics and group data;
4)	HOSMA11	Grade 11 mathematics and group data;
5)	HOSSCI3	Grade 3 science and group data;
6)	HOSSCI7	Grade 7 science and group data;
7)	HOSSCI11	Grade 11 science and group data;
8)	HOSCIRC	Data from the station administration;
9)	HOSSUGAR	Data from the "Sugar Cubes" full investigation;
10)	HOSPEGBD	Data from the "Pegboards" full investigation;
11)	HOSDENSI	Data from the "Density" full investigation;
12)	HOSSURVI	Data from the "Survival" full investigation;

The second task required developing a data entry system to permit easy input and modification of the data. This system was written using a menu driven concept that effectively isolated data in each of the files described above while allowing easy access to individual student records through the use of the student codes.

NAEP used the SAS statistical package to generate encrypted data sets that contained not only the raw data, but also summary statistics for each of the portions of the assessment. For the 1986 NAEP assessment items given as the first part of the group administration, these summary statistics included the answer key for each cognitive item, the number of items each student answered correctly, the number omitted, and the number not reached. Similar summary statistics were generated for the group and station activities and for the full investigations.

Two research assistants were responsible for entering the data on a VT100 terminal which was used with a modem to access the Princeton University mainframe. Data was entered twice whenever possible to ensure that all scores were entered accurately.

2. The Limitations of the Data

The purpose of the pilot test was two-fold. First, NAEP wanted to see if it would be possible to field such complex materials, even on a limited scale. Because this type of assessment is very rare in the United States, managing the equipment involved, obtaining school cooperation, training administrators, and actually collecting students' responses all were special hurdles. Second, if the logistics of the administration went well, NAEP wanted to know if these types of tasks would be appropriate for an actual national assessment. More specifically:

- Did students appear to understand the questions and equipment?
- Did the difficulty level of the tasks appear appropriate to the grade levels sampled?
- Were students motivated by the tasks?
- Could we detect any evidence of systematic bias?
- Did the results seem to make sense from the perspective of what the tasks were designed to measure?
- Would the results of a national assessment yield useful information?

The data obtained from the pilot study were adequate for most of these purposes. A total of 907 students responded to the pilot test materials. Data were available for 286 third-grade students, 317 seventh-grade students, and 304 eleventh-grade students. All students participated in the group administrations, but the sample sizes for the "hands-on" tasks were smaller. The logistics involved in pulling students from their classes and the constraints of conducting these "hands-on" sessions within the school schedule meant that fewer students than anticipated were assessed in the time allowed. We had hoped that one-half of the students, about 150, would participate in each set of station activities developed for that grade level. In actuality, the sample sizes are closer to 100 students for each station activity. The individual administrations seemed to be even more time consuming and the sample sizes on those tasks range from about 50 to 80 students across the grade levels.

Further, it must be stressed that this sample was not a representative probability sample. It was based on districts selected to give us a range of students, not in the proportions that reflect national population characteristics, but so we could tell if the exercises would be appropriate for low- as well as high-ability students. Also, the pilot-test sample was based on voluntary participation by the districts drawn in the initial descriptive sample. It seems reasonable in terms of demographics: at each grade level about one-half were male and one-half female; and about 70 percent were white students and 30 percent were minorities. In addition, the sample contained some students with little previous science or mathematics experience and others who reported a range of science and mathematics coursework. The background questions asked at each grade appear in Appendix B.

Finally, it should be noted that even when NAEP conducts national assessments based on a deeply stratified, multi-stage random probability samples, it does not obtain reliable results for individual students, only for groups of students. The results from the pilot test cannot be used to make judgments about student performance. They can only be used to make judgments about the tasks.

3. Analyses Conducted

Because the purpose of the pilot test was to obtain information about the appropriateness of the tasks, not reliable information about student performance, the small, unrepresentative sample limited the types of meaningful analyses that could be performed. NAEP computed the percentage of students responding to each part of each exercise at each score level. Results also were analyzed by gender, but information about any other subpopulations would have been based on very small cell sizes.

As mentioned earlier, students were not given overall scores on multi-part exercises and no attempt was made to combine scores in the analysis. However, this should be done with national assessment results and the pilot-study results indicated how this might be accomplished. As a matter of interest, NAEP did correlate performance on most of the pilot-tested tasks with performance on the 1986 assessment items. However, given the small number of items in each of the math and science tests and the limitations of the sample, these results are not particularly useful.

4. Third Advisory Panel Meeting

The third advisory panel for the project met in June. The five panel members, all of whom had participated on one or both of the earlier panels, were Audrey Champagne, Roberta Flexer, Gerald Kulm (formerly the project officer for OERI but now with the American Association for the Advancement of Science), James Minstrell, and Patricia Murphy. Also participating were Joanne Capper, representing the National Association of Chief State School Officers, and Richard Berry from NSF. The four project staff members who participated in the two previous panel meetings were joined by Andrew Mychajlowycz who had responsibility for data management.

The purpose for the panel meeting was to review and critique the pilot-tested tasks, review the data, and make suggestions for task revision. All the tasks were displayed as they were set up during the pilot tests and all the participants tried each of the various activities. This familiarized them with what the students had actually been asked to do and enabled them to critique the tasks more effectively. The remainder of the meeting was devoted to discussions of the strengths and weaknesses of each task based on the panelists' judgments and the pilot-test results. The panelists also discussed the overall potential of the task for national assessment and recommended ways to report data from a national assessment. Patricia Murphy's comments on how the APU science team had handled similar assessment issues were particularly helpful.

The panel members were very enthusiastic about the pilot-tested tasks. They were extremely impressed by the innovative nature of the tasks and agreed that an assessment consisting of such activities would have a positive impact on curriculum and coursework in mathematics and science. They further agreed, especially considering the lack of student experience with these types of materials in their classrooms, that most of the tasks seem to be at about the right difficulty level. At each grade level, essentially every student attempted each task they were given. Also, students appeared to be fairly successful on the sorting and classifying tasks and able to understand and complete the data interpretation tasks.

Again, the pilot-test data must be interpreted with caution, but it did appear that students had more difficulty with the tasks based on observing scientific and mathematical principles. Also, it appeared that students were generally unfamiliar with the principles involved. These results substantiated the validity of these tasks as emphasizing thinking rather than knowing. Further, in conducting the activities and observing the results, students did not appear to search for relationships--or at least they did not volunteer those kinds of responses unless explicitly asked to do so. If the question explicitly asked the students to determine a relationship, they generally were able to do so. However, if the question simply asked them to write down what they noticed, the responses tended to be descriptive step by step records rather than generalizations of the relationships they had observed. A national assessment would need to incorporate a variety of these types of questons to insure interpretable results. Still, students responded to these tasks and improved performance was noted across the three grade levels for those tasks given at more than one level.

As was expected on the full investigations, students did not appear to be adept at conducting experiments and manipulating the variables involved. But, similar to the results obtained in England, Wales, and Northern Ireland, students did recognize the major variables and take measurements in conducting their experiments. Also, response levels were high and improvement was evidenced across the grade levels.

I. Review of Assessment Tasks

Although the tasks as a whole were positively received, the panel members made a number of suggestions for improving the wording, equipment, questions, administration, and scoring of the individual tasks. These are detailed in Part II, but some illustrative examples follow:

- For Sand and Tubes and Rolling Funnels, it was suggested that students should be asked to predict what would occur, and that these activities might be administered to groups of students.
- A foods classification and/or sort task with the potential for assessing the quality of the students' classifications was proposed.
- Vertebrae and Conductivity (pilot-tested at grade 11) and Water on Brick (pilot-tested at grade 3) also could be used at grade 7. (APU has used comparable exercises for age 13.)

II. Additional Recommendations and Suggestions

- The scoring guides should be revised to reflect finer gradations of behavior. This would provide better information about students' different approaches to problem solving tasks.

- Students also should be evaluated on their performance across the parts of each task. For example, Patricia Murphy suggested that the different approaches taken by students in solving the full investigations be classified into different levels of competence. Criteria for competence could be defined in terms of: 1) how students conceptualized the problem, 2) how reliably they manipulated the independent variables, and 3) how efficiently they measured the dependent variable.
- It would be important to obtain results by race/ethnicity.
- A national assessment should investigate the relationship between performance on the problem-solving tasks and curriculum and coursework.

5. Summary and Recommendations

The development and pilot testing of innovative tasks to assess higher-order thinking in mathematics and science has presented a tremendous challenge to the project staff, but the outcomes demonstrate that "hands-on" assessment in the schools is feasible, albeit costly, time consuming, and demanding on the schools and the exercise administrators. The enthusiasm of the advisory panels, the school cooperation, and the face validity of "hands-on" tasks for assessing higher-order thinking in science and mathematics indicate that a national assessment of higher-order skills would be of great interest and utility.

The Tasks

Thirty different tasks were pilot tested of which six were group exercises, twenty station activities, and four full investigations. Eleven of the exercises were pilot tested in one grade only; the others were tried in two or three grades. Based on the review by the third advisory panel of the tasks with their equipment and pilot-test data, the panel's discussion and recommendations, and the summary comments on each of the tasks, there are seventeen tasks that can be recommended for potential future use unchanged or with minor revisions or equipment improvement that would not require new pilot testing, seven for which the ideas were good enough to warrant the needed revision and new pilot tests, three that would need new equipment and/or materials, and three that were not recommended.

1. Tasks Available For Future Use Essentially Unchanged

    Group: Whirlybird-Grade 3 and 7, Hair Color-Grade 3, Triathlon-Grades 3, 7, and 11, Number Relationships-Grade 7 and 11, Heart Rate and Exercise-Grade 11

    Stations: Birds(classify)-Grade 3, Seeds(classify)-Grades 3, 7, and 11, Seeds(sort)-Grade 7, Vertebrae(sort)-Grade 11 and also extended to Grade 7, Double Staircase-Grades 7, and 11, but not 3, Wig-Wag-Grades 3 and 7, Water on Brick-Grade 3 and also extended to Grade 7, Magnet and Compass-Grade 11, Conductivity-Grade 11, but could be extended to Grade 7

    Full Investigations: Sugar Cubes-Grade 3, Density-Grade 7 and 11, Survival-Grades 7 and 11

Although the panels especially liked the individually administered full investigations, these tasks are much more costly and time consuming than self-administered station activities. Inclusion of full investigations in a national assessment is therefore dependent on the total level of support for the project. The panel recommended use of Sugar Cubes at grade 3 and Survival at grades 7 and 11 if only one full investigation at a grade could be included in a national assessment.

2. Good Ideas Worth Major Revision and New Pilot Testing

    Stations: All the computer-administered tasks - i.e. Gumball Game-Grades 3, 7, and 11, Circle Game-Grade 3, Numbers Game-Grades 7 and 11; Sand and Tubes-Grades 3, 7, and 11 and Rolling Funnels-Grades 3, 7 and 11 could be turned into administrator-demonstrated group exercises or computer response exercises including prediction of the result; Magnets-revised and possibly extended to all three grades; Balance Scale-Grades 7 and 11

3. Need New Equipment or Materials

    Stations: The ideas for Bubbles, Bird(sort), and Tubes and Capillarity could be retained with improved or different apparatus or resource materials.

4. Not Recommended

    Group: Restaurant

    Stations: Sugar Cubes (as a station for Grade 7) was simply too complex to be a station activity.

    Full Investigation: Pegboards

Overall, the administrations in the schools went better, with fewer problems, than had been expected. However, problems that affected the quality of the data on the computer-administered exercises and on the full investigations were identified during the scoring and data analysis phases.

In using computer-administered tasks in future assessments, it will be necessary to develop rigorous, written procedures for the administrators who set up and monitor the computer tasks to prevent loss of data through administrator or student error. Administrators also will need more extensive training in the use of the computer and the requirements to operate specific programs.

For the individual investigations, administrators need more intensive training on how to observe the students and record what they observe. Therefore, it is strongly recommended that plans for any operational use of full investigations include the video-taping prior to the training period of several students at each grade as they carry out the investigation. The video-tapes would then become the actual cases on which the administrators could practice and compare results until agreement is reached.

Although the scoring guides were adequate for this project's purpose of assessing the quality and feasibility of the tasks, there were a number of tasks in which refinement of the guides would be desirable. A number of the scoring guides could be expanded to differentiate between responses that were clustered together. Further, substantial thought needs to be given to the assessment priorities. It is clear that a national assessment of these tasks could yield very worthwhile information. Yet it is doubtful that it could answer all the questions raised by NAEP's consultants. The goals would have to be clearly defined and once these were determined, appropriate analyses could be designed.

In this project, NAEP has made a good start toward a national assessment of higher-order thinking in science and mathematics. A number of tasks are available for use. But more would be needed if a full set of "hands-on" station activities assessing a broad range of skills is to be used at each grade. The extent of additional developmental work, not only in task development, but in other areas as well, necessary to conduct a national assessment, would very much depend on the goals and scope of that assessment.

APPENDIX A

EQUIPMENT LISTING

I. GROUP EXERCISES

Whirlybird

Horizontal rotor and base, 6 ball bearings of equal mass and volume, spare rubber bands and a spare ball bearing.

Hair Color

No apparatus needed

Triathlon

No apparatus needed

Number Relationship

No apparatus needed

Heart Rate and Exercise

No apparatus needed

Restaurant

No apparatus needed

II. STATION EXERCISES

Sand and Tubes

Three identical capped glass test tubes labelled A, B, and C, each filled with sand to different levels; one empty capped glass test tube labelled D; wooden incline with START clearly printed on the top of the incline; paper and pencils.

Rolling Funnels

A double cone made with two identical plastic funnels; a wooden board with two diverging rails and points at opposite ends labelled A and B; an empty tin can.

Gumballs

Apple II Series Computer with 48K memory, diskette with program, paper and pencil.

The Circle Game

Apple II Series Computer with 48K memory, diskette with program, paper and pencil.

The Numbers Game

Apple II Series Computer with 48K memory, diskette with program, paper and pencil.

Birds (classify)

Four colored photographs of birds labelled A, B, C, and D that are individually mounted on cardboard. Birds should differ in morphology (type of legs, beak, size, and coloring).

Birds (sort)

Seven colored drawings of birds labelled A to G that are individually mounted on cardboard. Birds should vary in morphology (color of breast, beak, size and crest).

Wig-Wag

One inertia balance, two large C-clamps, one block of lead labelled A, one block of aluminum labelled B, one block of wood labelled C, one block of balsa wood labelled D.

Magnets (strength)

Two disk magnets labelled A and B that are comparable in mass, size, shape, and external appearance (strength of magnets should be such that one magnet is 4-5 times stronger than the other one); large metal paper clips; assorted metal washers, plastic poker chips, paper and pencil.

Water on Brick

Eyedroper, small bottle filled with water; small equal-sized pieces of plastic, painted wood, brick, metal, roof shingle, and an unknown material (piece of porous cinder block) in a transparent, plastic bag; magnifying glass, paper and pencil.

Bubbles

Small and large bubble wand of different shapes (square, circular, and triangular); paper towels, 1 small bottle of bubble mixture (containing dishwashing liquid and water), paper and pencil. For grade 3 students only the square and circular wands will be used.

Balance Scale

A balance scale set up and balanced with equally spaced holes for hooks, five 10 gram metal washers, one 30 gram plastic film canister; paper and pencil.

Seeds (classify)

Containers filled with samples of labelled but unnamed seeds: A=caraway seeds, B=cumin seeds, C=black peppercorns, D=millet seeds, E=fennel seeds, F=all spice, G=white peppercorns, H=yellow mustard seeds, J=fenugreek seeds, X=coriander, Y=barley. For the grade 3 students, only groups 1 and 2 will be used.

Double Staircase

"Double staircase" of wooden blocks that is 4 blocks high, and glued to a wooden base; 24 loose wooden blocks that are identical to those used in the staircase; graph paper and pencil.

Vertebrae (grouping)

Eleven bones labelled A-L as follows: A=Lumbar dog, B=Cervical rabbit, C=Thoracic dog, D=Thoracic cat, E=Lumbar dog, F=Atlas coyote, G=Cervical rabbit, H=Cervical dog, J=Lumbar rabbit, K=Thoracic rabbit, L=Lumbar rabbit.

Seeds (sort)

Containers filled with samples of labelled but unnamed seeds: A=caraway seeds, B=cumin seeds, C=black peppercorns, D=millet seeds, E=fennel seeds, F=all spice, G=white peppercorns, H=yellow mustard seeds, J=fenugreek seeds. (Group A=A, B, and E; Group B=C, F, and G; Group C=D, H, and J).

Tubes and Capillarity

Beaker containing colored water, five small open-ended glass tubes labelled A, B, C, D and E, of equal length but different interior diameters, and one open-ended glass tube labelled X of the same diameter as one of the five, a six-inch ruler (Administrator should make sure that only five tubes are placed in the water. The sixth tube should be placed along side but not in the beaker and should match the size of one of the five tubes in the solution). The dish should be filled up to the top before every administration.

Conductivity

Five sealed black boxes labelled A-E containing the following materials: A=a piece of copper wire, B=a resistor, C=a piece of wood, D=a diode, E=a micro relay; three 1.5-volt batteries in holder; one circuit, set up and preset with resistance; two contacts, two sockets mounted on board springs or metal sloping blocks; three spare batteries.

Magnet and Compass

Sealed box labelled X containing two bar magnets fixed firmly in position, a compass, a work sheet depicting a rectangular box the same size as box X and ten circles around the perimeter of the rectangle, paper and pencil.

Sugar Cubes

Six small glass beakers, sugar cubes in packet, six packages of granulated sugar each containing the same mass of sugar as in one cube; stop watch; hot water in thermos.

III. FULL INVESTIGATION EXERCISES

Sugar Cubes

Six small glass beakers, sugar cubes in packet; six packages of granulated sugar each containing the same mass of sugar as in one cube; hot water in thermos ($50^{\circ}C-60^{\circ}C$); two stirrers, stop watch, graduated beaker, measuring cup, small ruler, paper towels, paper and pencil.

Pegboards

Nine pegboards of three different lengths and three different widths, stop watch, 12-inch ruler, two ring stands, two clamps, two rods and hooks.

Density

Three different sized blocks, labelled A, B, and C of different shapes and of materials of different densities; a large open box; spring scale, ruler, hand calculator, paper and pencil (Note: The blocks will be a rectangular solid, a cube, and a triangular block which is half a rectangular solid).

Survival

Five cans labelled A-E (two identical aluminum cans A and B, one plastic can E with the same dimensions as A and B, one aluminum can C that is the same height as A, B, and E but of a larger diameter, one aluminum can D with the same diameter as A, B, and E but shorter height); 110°C thermometer, a stopwatch, rubber bands, pins, transparent tape, scissors, electric kettle, two grduated cylinders, sheets of blanket, sheets of plastic, electric fan, small ruler, graph paper, thermos, paper towels, and pencils.

IV. UTILITY KIT AND ANCILLARY MATERIAL

Extension Cord
Glue
Scotch Tape
Magic Marker
Scissors
Pliers
Screwdriver
Pencil Sharpener
Strapping Tape
Screws for Whirly Bird
Extra Labels
Extra Betteries (Timers and Stop Watch)
Allen Wrench (to adjust balance beam)
Timer
2 pads (extra paper if needed)
18 pencils
Station signs 1-6
Clipboard
Graph paper
Ruler

APPENDIX B

GRADE 3

GROUP EXERCISES

3M

SECTION 1

For each of the questions that follow, fill in the oval next to the answer you choose.

1. Are you male or female?

   ○ Male

   ○ Female

2. Which best describes you?

   ○ White

   ○ Black

   ○ Hispanic (Mexican, Mexican American, Chicano, Puerto Rican, Cuban, or other Spanish or Hispanic background)

   ○ Asian or Pacific Islander

   ○ American Indian or Alaskan Native

   ○ Other (what?)____________________

3. If you are Hispanic, what is your Hispanic background?

   ○ I am not Hispanic.

   ○ Mexican, Mexican American, or Chicano

   ○ Puerto Rican

   ○ Cuban

   ○ Other Spanish or Hispanic background

Please continue on next page. ▶

4. How often do you usually have a science class in school?

○ Every day

○ Several times a week

○ About once a week

○ Less than once a week

○ Hardly ever or never

5. Which of the topics listed below have you learned? Fill in one oval on each line.

	Have learned	**Have not learned**
How to add	○	○
How to subtract	○	○
How to multiply	○	○
How to divide	○	○
What fractions are	○	○
How to tell time	○	○

6. How often do you usually have a mathematics class in school?

○ Every day

○ Several times a week

○ About once a week

○ Less than once a week

○ Hardly ever or never

Please continue on next page. ▶

GRADE 7

GROUP EXERCISES

7S

SECTION 1

For each of the questions that follow, fill in the oval next to the answer you choose.

1. Are you male or female?

   ○ Male

   ○ Female

2. Which best describes you?

   ○ White

   ○ Black

   ○ Hispanic (Mexican, Mexican American, Chicano, Puerto Rican, Cuban, or other Spanish or Hispanic background)

   ○ Asian or Pacific Islander

   ○ American Indian or Alaskan Native

   ○ Other (what?)____________________

3. If you are Hispanic, what is your Hispanic background?

   ○ I am not Hispanic.

   ○ Mexican, Mexican American, or Chicano

   ○ Puerto Rican

   ○ Cuban

   ○ Other Spanish or Hispanic background

Please continue on next page. ▶

4. What is the main thing you are studying in science this year?

○ I am not studying science this year.

○ Life science (plants and animals)

○ Physical science (matter and energy)

○ Earth science (weather, rocks, stars)

○ General science (a mixture of the above)

○ Other

5. What kind of mathematics class are you in this year?

○ I am not taking mathematics this year.

○ Regular mathematics

○ Pre-algebra

○ Algebra

○ Other

Please continue on next page. ▶

GRADE 11

GROUP EXERCISES

11M

SECTION 1

For each of the questions that follow, fill in the oval next to the answer you choose.

1. Are you male or female?

○ Male

○ Female

2. Which best describes you?

○ White

○ Black

○ Hispanic (Mexican, Mexican American, Chicano, Puerto Rican, Cuban, or other Spanish or Hispanic background)

○ Asian or Pacific Islander

○ American Indian or Alaskan Native

○ Other (what?)____________________

3. If you are Hispanic, what is your Hispanic background?

○ I am not Hispanic.

○ Mexican, Mexican American, or Chicano

○ Puerto Rican

○ Cuban

○ Other Spanish or Hispanic background

Please continue on next page. ▶

4. Are you currently taking a class in any of the following subjects? Fill in one oval on each line.

	Yes	No
Mathematics	○	○
Science	○	○
Computers	○	○

5. Counting what you are taking now, have you ever taken any of the following mathematics or science courses? Fill in one oval on each line.

	Yes	No
Mathematics:		
General, business or consumer mathematics	○	○
Pre-algebra or introduction to algebra	○	○
First-year algebra	○	○
Second-year algebra	○	○
Geometry	○	○
Trigonometry	○	○
Pre-calculus or calculus	○	○
Science:		
General science	○	○
Biology	○	○
Chemistry	○	○
Physics	○	○

Please continue on next page. ▶

NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

A PILOT STUDY OF HIGHER-ORDER THINKING SKILLS ASSESSMENT TECHNIQUES IN SCIENCE AND MATHEMATICS

FINAL REPORT - PART II
PILOT-TESTED TASKS

NOVEMBER 1986

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The ideas for the majority of the exercises for this project were taken from questions constructed for the national monitoring of science performance carried out by the Assessment of Performance Unit in the U.K. We acknowledge the cooperation of the U.K. Department of Education and Science and of the unit in the Centre for Educational Studies in King's College London in making these questions available. However, the questions have been substantially changed to function with our, very different, framework so that the results will not be comparable with U.K. results. The U.K. A.P.U. is not responsible for the use we have made of their ideas.

PART II

HIGHER ORDER SKILLS TASKS

Introduction

In Part II, the pilot-tested tasks are presented individually. The Group tasks are presented first, followed by the Station Activities, and then the Individually Administered Full Investigations. The presentation for each task consists first of the task as the students saw it; followed by directions for the administrator and the observation checklist, where these are pertinent; a description of the apparatus; the scoring guide with illustrative examples of each score level; and summary comments about the task.

The data on which the comments are based included student performance on each task by grade and by sex and the correlation coefficient between the number right on the mathematics and science items and student data for most of the tasks. Separate analyses by sex were conducted to determine if there were any obvious gender biases in the tasks. No tests for significance were done on the gender results.

Chapter 1 consists of the group exercises; Chapter 2 contains the self-administered station activities; and Chapter 3 contains the indvidually administered full investigations.

CHAPTER 1

GROUP EXERCISES

Activity Identification	Grade(s)
Whirlybird	3,7
Hair Color (Logic)	3
Triathlon	3,7,11
Number Relationships	7,11
Restaurant	7,11
Heart Rate and Exercise	11

GROUP EXERCISES

3M

SECTION 2

1. WATCH AS THE TEACHER DOES THE EXPERIMENT.

WATCH THE "WHIRLYBIRD" ARM CAREFULLY EACH TIME UNTIL IT STOPS.

(1) THE BALL BEARINGS WERE PUT IN THE TWO OUTSIDE HOLES. THE "WHIRLYBIRD" ARM WAS WOUND UP EXACTLY THREE TIMES AND LET GO.

(2) THE BALL BEARINGS WERE PUT IN THE NEXT TWO HOLES. THE ARM WAS WOUND UP EXACTLY THREE TIMES AND LET GO.

(3) THE BALL BEARINGS WERE PUT IN THE NEXT TWO HOLES. THE ARM WAS WOUND UP EXACTLY THREE TIMES AND LET GO.

WHAT WAS DIFFERENT ABOUT THE WAY THE WHIRLYBIRD ARM MOVED WHEN THE STEEL BALLS WERE IN THE DIFFERENT HOLES?

(A) USE THIS SPACE TO JOT DOWN NOTES ABOUT WHAT YOU SEE HAPPEN WHEN THE STEEL BALLS ARE MOVED TO DIFFERENT HOLES?

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

Please continue on next page. ▶

Activity Identification: Whirlybird

Grade(s): 3,7

Method of Administration: Group Activity

Content Area: Science-Physics

Apparatus required: "Whirlybird" apparatus, 6 ball bearings of equal mass and volume, spare rubber bands and a spare ball bearing. (See picture below.)

Group Activity- 3,7
(to be read by the A)

The piece of equipment in front of you is called a Whirlybird. This part of it is called the Whirlybird arm (A should point towards the arm). **If you look at the arm closely you will see that it has three holes on each side.**

I am going to put the steel balls on different holes to see what happens when I wind the arm three times and let go.

When I have finished, I will ask you to answer the question on the paper in front of you. "What was different about the way the Whirlybird arm moved when the steel balls were in the different holes?"

Whirlybird
Section 2 - Group
Grade 3M, 3S - #1
7M, 7S - #1

Look what happens when I put the steel balls in the outside pair of holes and wind the arm three times. Now I am going to let go of the arm. Watch carefully.

Now I am going to move the steel balls to the middle pair of holes and wind up the arm three times. Watch what happens as the arm unwinds.

Now I'm going to move the steel balls to the inside pair of holes. Watch carefully as the arm unwinds.

I am going to do the experiment all over again. You may want to jot down some notes about what you see happen when the steel balls are moved to different holes.

(A should repeat the experiment and then give the following instructions.)

Now answer the question in front of you. The question is "What was different about the way the Whirlybird arm moved when the steel balls were in the different holes?" Think back on how the Whirlybird arm acted.

Score 3 pts. for a response that accurately describes how the Whirlybird moved in relation to the positioning of the ball bearings in the holes.

Score 2 pts. for a response that describes how the Whirlybird moved but doesn't specify the relationship between the position of the holes and the speed of the Whirlybird arm (e.g. It moved faster the second time.).

Score 1 pt. for an incorrect or irrelevant statement about what happens as the ball bearings were moved to different holes.

Score 0 for no response.

Skills involved:

In this exercise students need to infer a relationship between two variables based on their observations.

THIRD GRADE SCORE POINT 3

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

When the steel bals where on the two edges, the
"whirlybird' went slow. When the steel bals where
in the two middles it went normaly. When they
where in the inner holes, it went fast ③

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

When the steel balls were
outside it moved fast. When
they were in the middle it
moved faster. When they were
in the inside it fastest. ③

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

The closeser they are to the
middle the faster it goes. ③

SEVENTH GRADE SCORE POINT 3

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

When the balls are on the outside holes they move slow. When the balls are moved to the middle they move fast. When the balls are moved to the inside they move faster.

3

Please continue on next page. ▶

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

When the balls were on the outside the whirlybird moved slower them when they were on the inside

③

Please continue on next page. ▶

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

It turns faster each time the steel balls are moved closer to the center of the arm

③

Please continue on next page. ▶

THIRD GRADE SCORE POINT 2

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

The brids arm got faster and faster

2

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

the first time it went fast
the second time it went faster.
the therd time it went fastest.

2

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

Every time the balls were moved it went faster.

2

SEVENTH GRADE SCORE POINT 2

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

The first time it went slow
The next time is went faster
The last time is went even
faster

②

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

The first time it was fast and got
slow then fast again The second time
was fast but a little slower the third
time was fast and got slow — quickly

②

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

Ala what happend was
every time the balls were
in different holes the Speed
increased

②

THIRD GRADE SCORE POINT 1

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

The ball bearings were in the Lastholes.

1

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

it was like the Whoule Bird
Was going to fly.

1

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

It want slower then the
others.

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

When the balls were on the outside
it went around once the others
didn't, the second to the last as
the inside

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

It started out fast, then it slowed down.
whenever the steel balls got
moved, nothing happend All the time
it just went fast, then it slowed down.

(B) USE THIS SPACE TO WRITE DOWN YOUR ANSWER TO THE QUESTION IN THE BOX.

3 times in the outside holes
3 times in the middle holes
2 times in the first holes
spinning around.

Comments on Whirlybird (Grades 3 and 7)

This is the only exercise in which the students watched a demonstration by an administrator. This exercise required students to observe what happened, interpret their observations, and report their conclusions. The scoring levels attempted to differentiate between those who inferred the relationship and made it explicit, and those who simply reported their observations. The performance by students on this exercise indicates that the task is appropriate for both grades 3 and 7. More seventh graders than eleventh graders stated the relationship between variables which may indicate a developmental difference. There was little difference in performance between boys and girls.

The advisory panel expressed some concern that, given the wording of the question and the order in which the demonstration was carried out, some students, particularly among third graders who scored in the level 2 category, had inferred the relationship and did not see the need to say more than "it went faster." It was suggested that, for future use, it might be possible to reword the question to try to elicit the explicit statement of relationship without being directive.

2. MARY AND SUE ARE TWO YOUNG GIRLS.
ONE GIRL HAS BLUE EYES AND THE OTHER GIRL HAS BROWN EYES.
ONE GIRL HAS BROWN HAIR AND THE OTHER GIRL HAS BLACK HAIR.
MARY HAS BLUE EYES.

THE GIRL WITH BROWN HAIR DOES NOT HAVE BROWN EYES.

(A) WHAT COLOR HAIR DOES MARY HAVE?

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

Please continue on next page. ▶

Hair Color (Logic)
Section 2 - Group
Grade 3M, 3S - #2

A & B) Score 4 pts. for the correct answer - **brown** - with an explanation that uses both hair color and eye color.

Score 3 pts. for a correct answer with an explanation that uses either hair color or eye color but not both.

Score 2 pts. for a correct answer with an explanation that is irrelevant or erroneous or with no explanation (i.e no response in part B).

Score 1 pt. for an incorrect answer with or without an explanation.

Score 0 for no response.

Skills involved:

In this exercise the student needs to use transitive reasoning in order reach a conclusion about given information.

THIRD GRADE SCORE POINT 4

(A) WHAT COLOR HAIR DOES MARY HAVE? BROWN 4

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

The 1st clue said the girl with Brawn hair does not Have Brown eyes and Mary has Blue eyes.

(A) WHAT COLOR HAIR DOES MARY HAVE? Brown hair 4

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

Mary has Blue eyes it says. So the girl with brown hair doesn't have brown eyes so she had blue eyes and thats Mary

(A) WHAT COLOR HAIR DOES MARY HAVE? 4

brown Hair

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

Mary has blue eyes and Sue has brown eyes so if Sue doesn't have brown hair then Mary does.

THIRD GRADE SCORE POINT 3

(A) WHAT COLOR HAIR DOES MARY HAVE?
Brown 3

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.
The girl with brown hair
does not have brown eyes,
is put above the question.

(A) WHAT COLOR HAIR DOES MARY HAVE? Brown 3

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.
Mary has blue eyes and
Sue has brown eyes. So
that would mean that Mary
would have brown hair.

(A) WHAT COLOR HAIR DOES MARY HAVE? 3

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.
Mary has brown hair. They said
the girl with brown hair does
not have brown eyes. So
if she does not have brown
eyes
it must
be mary,

THIRD GRADE SCORE POINT 2

(A) WHAT COLOR HAIR DOES MARY HAVE? 2

brown

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

I gust thoght about it

(A) WHAT COLOR HAIR DOES MARY HAVE? 2

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

Mary has brown hair.

(A) WHAT COLOR HAIR DOES MARY HAVE? 2

Brown

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

Mary came before Sue
at the top

THIRD GRADE SCORE POINT 1

(A) WHAT COLOR HAIR DOES MARY HAVE? Black Hair 1

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

It says the girl
with Brown Hair
dos not have Brown
eyes.

(A) WHAT COLOR HAIR DOES MARY HAVE? Blue.

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER. E 1

I decided to pick blue eyes
because they said that Mary
has blue eyes and the girl that
brown hair didn't have brown eyes.

(B) WRITE DOWN HOW YOU FIGURED OUT YOUR ANSWER.

Mary has black hair.
The clue gave me the
answer.

Comments on Hair Color (Grade 3)

This logic problem for third graders worked well and appears to illustrate what the APU has found; namely, that students are more likely to be able to do problems than provide good explanations for their answers. Over half of the students answered correctly, but only a few managed to offer an explanation that took both hair color and eye color into account. Girls in the sample performed slightly better than boys.

Third graders seemed to understand the question and all but 5 percent at least attempted it. The advisory panel thought that this exercise could be used without change in a future assessment.

3. JOE, SARAH, JOSÉ, ZABI, AND KIM DECIDED TO HOLD THEIR OWN OLYMPICS AFTER WATCHING THE OLYMPICS ON TV. THEY NEEDED TO DECIDE WHAT EVENTS TO HAVE AT THEIR OLYMPICS. JOE AND JOSÉ WANTED A WEIGHT LIFTING AND A FRISBEE TOSS EVENT. SARAH, ZABI, AND KIM THOUGHT A RUNNING EVENT WOULD BE FUN. THE CHILDREN DECIDED TO HAVE ALL THREE EVENTS. THEY ALSO DECIDED TO MAKE EACH EVENT OF THE SAME IMPORTANCE.

ONE DAY AFTER SCHOOL THEY HELD THEIR OLYMPICS. THE CHILDREN'S MOTHERS WERE THE JUDGES. THE MOTHERS KEPT THE CHILDREN'S SCORES ON EACH OF THE EVENTS.

THE CHILDREN'S SCORES FOR EACH OF THE EVENTS ARE LISTED BELOW:

CHILD'S NAME	FRISBEE TOSS	WEIGHT LIFT	50-YARD DASH
JOE	40 YARDS	205 POUNDS	9.5 SECONDS
JOSÉ	30 YARDS	170 POUNDS	8.0 SECONDS
KIM	45 YARDS	130 POUNDS	9.0 SECONDS
SARAH	28 YARDS	120 POUNDS	7.6 SECONDS
ZABI	48 YARDS	140 POUNDS	8.3 SECONDS

(A) WHO WOULD BE THE ALL-AROUND WINNER?

____

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

____

____

____

____

► **STOP** Do not continue until told to do so.

Triathelon
Section 2 - Group
Grade 3M, 3S - #3
7M, 7S - #2
11M,11S - #1

Score 4 pts. for accurate ranking of the children's performance on each event and citing Zabi as the overall winner.

Score 3 pts. for using a ranking approach to evaluate the children's performance but misinterpreting performance on the dash event (i.e mistaking longer times for better scores) and therefore, citing the wrong child as the overall winner.

Score 2 pts. for a response which cites an overall winner or a tie between children with an explanation that demonstrates some recognition that a quantitative means of comparison is needed to choose the winner.

Score 1 pt. if the student makes a selection of an overall winner with an irrelevant or non-quantitative comment or without providing any explanation.

Score 0 for no response.

Note to scorers: Because we are interested more in the students' approach to the problem than their accuracy in solving it, the cases in which students rank accurately but add incorrectly or misread their own notes to cite Jose' as the winner should be scored with code pt. 4.

Skills involved:

In this exercise students need to design an approach for evaluating and interpreting a set of data.

THIRD GRADE SCORE POINT 4

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabh

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK. ④

she had therd best running time, 3 best weight lifting, and best frisbee toss.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabt

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

because put together he had abetter plac he had 1st 3rd 4th José was 4th 2nd 2nd Kim was 2nd 4th 4th Joe was 3rd 1st 5th Sarah was 5th 5th 1st ④

~~3 1 5~~
~~4 2 2~~
~~2 4 4~~
~~5 5 1~~

④

► **STOP** Do not continue until told to do so.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

④

Joe was 2nd, 1st, and 5th. Jose was 4th, 2nd and 2nd, Kim was 2nd, 4th and 4th. Sarah was 4th, 5th, and 1st, Zabi was 1st, 2nd, and 3rd,

Joe 15-8*=7
Jose 15-8=7
Kim 15-10=5
sarah 15-10=5
Zabi 15-7=8

8 is highest

*2+1+5=8

④

SEVENTH GRADE SCORE POINT 4

(A) WHO WOULD BE THE ALL-AROUND WINNER?

ZABI

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

④

I Decided by how each person came in and that place to see who won

(A) WHO WOULD BE THE ALL-AROUND WINNER?

ZABI

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

④

I wrote in order, all the scores from first place, to fifth place. Then I added them up. Whoever had the least amount, won.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

4

ZABI

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

④

Zabi got one first & 2 thirds.
I counted 3 points for every
1st place they got and, 2 points
for 2nd place and 1 point
for thirds place

Zabi got the
most points

ELEVENTH GRADE SCORE POINT 4

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

I numbered each event from 1-5 - the best score is 5, the worst is 1. Then I added the three scores for each of the children. Zabi's score is 11, which is the highest.

④

(A) WHO WOULD BE THE ALL-AROUND WINNER?

ZABI

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

④

I GAVE THE WINNER OF EACH EVENT I PT. THE 2ND PLACE PERSON I GAVE 2 PT.S AND SO ON. I THEN ADDED UP ~~ALL~~ THE PT'S AND THE PERSON WITH THE LOWEST SCORE WON.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

④

I assigned each place a no. of pts (1st=5 pts 2nd= 4 pts, 3rd = 3pts, 4nd= 2pts, 5th= 1pt) and found each person's average no. of pts. Zabi had the highest average no. of pts.

THIRD GRADE SCORE POINT 3

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

Joe wan the wieght and 50 yard dash and Zabi won only the frisbee Zabi only won one event and Joe won two events plus won second place in the other event ③

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK. ③

1st place Frisbee toss
3rd place weight lift
4th place 50 yard Dash.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK. ②

Joe won 2 games. Josh won 0 games. Kim won 0 game Sarah won 0 game. And Zabi won 1 game.

SEVENTH GRADE SCORE POINT 3

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

Joe tossed 40 yards of frisbee and lifted 205 pounds at weight lift and ran 9.5 seconds in the 50 yard dash he lost by 5 yards for frisbee but won the rest of events. ③

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

E1

Joe got 40 yds. on the Frisbee, with 2 kids better & 2 kids worse than he; he got the best score for weight lifting & 50-yd dash. ③

(A) WHO WOULD BE THE ALL-AROUND WINNER?

JOE

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

I put 1st - 5th place for the events. Then I added up all their scores. The one with the least won. ③

Joe - 5
Jose - 10
Kim - 8
Sarah - 15
Zabi - 7

Joe has the lowest score

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

3

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

If all events are equal importance and you received 1 pt for 1st place, 2 for 2nd and 3 for 3rd then Joe would have received the most pts.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

3

Joe would be an all around winner because he got 2 firsts and 1 3rd, and the only other person who placed in all 3 events got 1 1st and 2 3rds.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

3

I found out who won 1-5 place in each event, Then I found out all of the placements that each person won. I then averaged them, and found that Joe placed 1.8.

THIRD GRADE SCORE POINT 2

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zali

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

②

Zali was all round winner because she had the most ponts.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

JOe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

②

I added all ~~theree~~ three points and Joe had the most.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

I found out by looking at the first one to see how much he could toss, lift, and run. I found out that Joe ran the fastest and lifted the most pounds.

SEVENTH GRADE SCORE POINT 2

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Sarah

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

②

Sarah becaus e when you add and then dividoall then up The lowest time is better. Thatpers'on is the quickest.

145
95
240

280

[illegible]

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

②

zabi did best at the Frisbee toss, lifted 140 lbs. and ran pretty well

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe would be the winner

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

②

I looked at the scores added them together and [illegible] came up with the answer

ELEVENTH GRADE SCORE POINT 2

②

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

If you add His frisbee toss with his weight lift, you get 245 lbs.. Now if you subtract his time from this score (245-9.5) you get his score, which is the highest score among them.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

JOE

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

The winner of the Frisbee toss was Zaki. The winner of the weight lifting was Joe and the winner of the 50-yd dash was JOE again so the person who won the most events was JOE

205
40
~~245 9.5 sec~~

170
+ 30 8.0 sec
210

~~130~~
~~+ 45 9.0 sec~~
~~175~~

28
~~120 7.0 sec~~
~~+ [illegible]~~

48
1.40
188 8.3 sec

(A) WHO WOULD BE THE ALL-AROUND WINNER?

José

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

José woued be the winners because his average of strength in the weight lift & his frisbee toss are almost the best - and his 50 yard dash time are almost the best. His overall average was the best.

THIRD GRADE SCORE POINT 1

(A) WHO WOULD BE THE ALL-AROUND WINNER?

ZABi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK. ①

By FRISBEE toss, WEiGHT LiFt and 50-YARD DASH

(A) WHO WOULD BE THE ALL-AROUND WINNER?

no one

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK. ①

no one is the all-around winner

(A) WHO WOULD BE THE ALL-AROUND WINNER?

JoE

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK. ①

JOE would be the winner because he got 40yards 205 pounds 9.5 seconds.

SEVENTH GRADE SCORE POINT 1

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

①

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

I pick Joe because it takes a lot to pick up 205 pounds.

①

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Joe would be the winner.

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

Because Joe lifted 205 pounds and in the 50 yard dash he got 9.5 seconds.

①

ELEVENTH GRADE SCORE POINT 1

(A) WHO WOULD BE THE ALL-AROUND WINNER?

ZAbi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

(A) WHO WOULD BE THE ALL-AROUND WINNER?

JOE

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

JOE 205 40 9.5 30.0

JOSÉ 30 170 8.0 28.0

KIM 45 130 5.0 26.5

SARAH 38 130 7.1 12.4

ZA 48 14 8.3 77.1

(A) WHO WOULD BE THE ALL-AROUND WINNER?

Zabi

(B) EXPLAIN HOW YOU DECIDED WHO WOULD BE THE ALL-AROUND WINNER. BE SURE TO SHOW ALL YOUR WORK.

did pretty good in all of the events.

Comments on Triathlon (Grades 3, 7, 11)

In this exercise, which was tried out at all three grade levels, students must decide upon an approach, and interpret the data, to reach a conclusion about the results of three athletic events. Further, the students must pay attention to the fact that the lowest time on the 50-yard dash is best although the highest number is best in the other two events. Many students at each grade misinterpreted what was best on the dash; almost one-third at grades 3 and 7 and about one-fifth at grade 11. The misuse of the dash was evidenced in a variety of ways. For example, some students ranked accurately except for the dash, other students responded "Joe because he won two". In some cases, students just added the numbers for three events and said "Joe won because he had the most points."

If the exercise is used in the future, the score range should be expanded to separate those students who said, "Joe because he won two" from the others now classified with them in score level 2. The potpourri of approaches used by other students currently placed at score level 2 are very different, including such methods as adding incompatible numbers, adding the frisbee distance to the pounds lifted and subtracting the dash time, and taking odd averages. The score level 1 included responses of no winners or multiple winners.

Although the task was very difficult for third graders, several attained scores at the two highest score levels. It may be appropriate to use this exercise for all grades in the future, particularly since the data shows development differences from grade 3 to 7 to 11 in the percent who worked out a ranking approach. Almost 20 percent at grade 7 and about 45 percent at grade 11 used a ranking approach. There was a wide variety in how this ranking was done, including ranking participants first, second, third, etc. in each event, leading to lowest score; assigning points, such as 5 to first place, to each place, leading to highest score; and finding out who would get the most medals, as in the Olympics.

Although there is little difference in performance on this task between boys and girls at grade 3, boys appeared to have less difficulty than girls at grades 7 and 11.

This exercise is recommended for future use with two minor changes: substituting parents for mothers and changing the heading for the 50-yard dash to TIME FOR 50-YARD DASH as a small clue to help students interpret that data.

3. Below are two columns of numbers, A and B. Begin by writing the answers to the multiplications in the blanks provided. Then answer the questions that follow.

A	B
3 x 5 = ___	4 x 4 = ___
4 x 6 = ___	5 x 5 = ___
5 x 7 = ___	6 x 6 = ___

(A) Look for the patterns in A and B. What should be the next line in each of the columns?

A	B
___ x ___ = ___	___ x ___ = ___

(B) Fill in the numbers in column A that would be on the same line as those given in column B below.

A	B
___ x ___ = ___	100 x 100 = ___

(C) Explain the relationship between the equations in column A and column B.

____

____

____

(D) Express this relationship in symbols as an equation for any number N.

Please continue on next page. ▶

Number Relationships
Section 2 - Group
Grade 7M,7S - #3
11M,11S - #2

a) Score 2 pts. for correct response:
$6 \times 8 = 48 \qquad 7 \times 7 = 49$
Score 1 pt. for an incomplete or incorrect response.
Score 0 for no response.

b) Score 2 pts. for correct response:
$99 \times 101 = 9999 \qquad = 1000$
(acceptable without the product - i.e. 99 x 101)
Score 1 pt. for an incorrect response.
Score 0 for no response.

c) Score 3 pts. for a complete or accurate explanation such as **The square of any number (or any number multiplied by itself) is one more than the product of the numbers one less and one more;** or **The product of two numbers that differ by two is one less than the square of the number between them.**

Score 2 pts. for an incomplete explanation that is correct as far as it goes such as **The product (answer) on the left is always one less than the product (answer on the right); The answer on the right is always one more than the answer on the left; The numbers on the left are one more and one less than the number squared (or multiplied by itself) on the right.**

Score 1 pt. for an incorrect or irrelevant explanation.

Score 0 for no response.

d) Score 2 pts. for a correct response such as:
$(n - 1)(n + 1) = n^2 - 1$ or $n \times n - 1$
$(n - 1)(n + 1) + 1 = n^2$ or $n \times n$
Score 1 pt. for an incorrect response.
Score 0 for no response.

Skills involved:

In this exercise students need to infer a relationship from a set of numerical patterns and express this relationship in a generalized form.

Part a

SEVENTH GRADE SCORE POINT 1

(A) LOOK FOR THE PATTERNS IN A AND B. WHAT SHOULD BE THE NEXT LINE IN EACH OF THE COLUMNS?

①

A	B
7 × 9 = 63	7 × 7 = 99

SEVENTH GRADE SCORE POINT 2

(A) LOOK FOR THE PATTERNS IN A AND B. WHAT SHOULD BE THE NEXT LINE IN EACH OF THE COLUMNS?

②

A	B
6 × 8 = 48	7 × 7 = 49

Part a

ELEVENTH GRADE SCORE POINT 2

(A) LOOK FOR THE PATTERNS IN A AND B. WHAT SHOULD BE THE NEXT LINE IN EACH OF THE COLUMNS?

A	B
6 x 8 = 48	7 x 7 = 49

2

ELEVENTH GRADE SCORE POINT 1

(A) LOOK FOR THE PATTERNS IN A AND B. WHAT SHOULD BE THE NEXT LINE IN EACH OF THE COLUMNS?

A	B
8 x 9 = 72	7 x 7 = 49

1

Part B

SEVENTH GRADE SCORE POINT 1

(B) FILL IN THE NUMBERS IN COLUMN A THAT WOULD BE ON THE SAME LINE AS THOSE GIVEN IN COLUMN B BELOW.

A	B
99 x 100= 990	100 x 100 = 1,000

①

SEVENTH GRADE SCORE POINT 2

(B) FILL IN THE NUMBERS IN COLUMN A THAT WOULD BE ON THE SAME LINE AS THOSE GIVEN IN COLUMN B BELOW.

A	B
99 x 101 = 9999	100 x 100 = 100,00

②

ELEVENTH GRADE SCORE POINT 1

Part B

(B) FILL IN THE NUMBERS IN COLUMN A THAT WOULD BE ON THE SAME LINE AS THOSE GIVEN IN COLUMN B BELOW.

A	B
99 x 101 = 9999	100 x 100 = 10000

2

ELEVENTH GRADE SCORE POINT 2

(B) FILL. IN THE NUMBERS IN COLUMN A THAT WOULD BE ON THE SAME LINE AS THOSE GIVEN IN COLUMN B BELOW.

A	B
9 x 11 = 99	100 x 100 = 1000

1

Part C

SEVENTH GRADE SCORE POINT 3

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

The numbers in column A are one increased one less than those in column B. The answers to column B are peefect squares, and answers to column A are always one less ③

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

The product in A is always 1 less than the product in B. The two numbers in A are always 1 less and 1 more than the identicle one in columb. ③

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

X times X is one greater the X-1 times X+1. ③

Part C

ELEVENTH GRADE SCORE POINT 3

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

3

In column B the numbers are multiplied by itself, but A is the numbers that comes before and after the number in column B. Therefore the answer is one number higher, than the other.

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

3

COLUMN A'S NUMERICAL VALUE IS ALWAYS 1 LESS THAN COLUMN B'S. COLUMN A TAKES THE NUMBER'S 1 HIGHER AND LOWER THAN IN COLUMN B AND MULTIPLIES THEM TOGETHER.

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

3

~~column B~~ : column A is multiplication of a number one less & one more than column B. column A's product is always 1 less than column B.

Part C

SEVENTH GRADE SCORE POINT 2

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

the answer to column A was one less then column b

②

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

each one in column A had a product 1 less than in column B

②

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

B is the same numbers multiplied ②

A is a 2 number difference

1st no. in [illegible] A is 1 less than 1st in B

1 more than 2nd in B

ELEVENTH GRADE SCORE POINT 2

Part C

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

2.

The first #(in col 1)of A is 1less than the 1st #(in Col. 1)of B. The 2nd #(in col 2) of A is 1 mor than the 2nd #(of column 2) of B

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

In column B the answer is just one after column A

2

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

Column B is same no. times itself while column A is the no. before and the no. after times each other

2.

Part C

SEVENTH GRADE SCORE POINT 1

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

A. Each number is one higher
B. Each number is the same ①

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

In column A the numbers are multiplied by 2 less than the other and B you times the number by the same number ①

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

each column has a patern for each problem, and the numbers used go in order ①

Part C

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

In column A the numbers are - always one more than the corresponding number in the preceding equation - In column B the number multiplyed by itself is always one more than the last one.

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

they both start at one number and increase by one each time. A - starts at 2 different numbers and B - starts at the same numbers

(C) EXPLAIN THE RELATIONSHIP BETWEEN THE EQUATIONS IN COLUMN A AND COLUMN B.

The numbers multiplied are increasing but they have started at different numbers.

Part D

SEVENTH GRADE SCORE POINT 2

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

column A column B

$(n-1)(n+1)$ $(n)(n)$

2)

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

column A column B

$(N+1) \times (N-1)$ N^2 or $N \times N$

(2)

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

A B

$B-1 \times B+1=C-1$ $B \times B = C$

(2)

Please continue on next page. ▶

ELEVENTH GRADE SCORE POINT 2

Part D

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

$$(N-1)\times(n+1)+1=n^2$$

$$(n-1)(n+1)+1=n^2$$

2

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

2

$\underline{A}$

$$n\times(n+2)=X$$

$\underline{B}$

$$(n+1)\times(n+1) \text{ or } (n+1)^2 = X+1$$

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N. $(N-1)\times(N+1)=(N^2-1)$

2

Please continue on next page. ▶

Part D

SEVENTH GRADE SCORE POINT 1

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

$8 \times N = 64$

①

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

$A \times B = C$

$n \cdot n = D$

①

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

$8 \times n = 64$

①

Please continue on next page. ▶

Part D

ELEVENTH GRADE SCORE POINT 1

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

A

$(N-1)\times(N+1)$

B

$N\times N$

1

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

Ⓐ

$(N)(n+2)$

$(n+1)(n+3)$

$(n+2)(n+4)$

$(n+3)(n+5)$

Ⓑ

$(n+1)(n+1)$

$(n+2)(n+2)$

$(n+3)(n+3)$

$(n+4)(n+4)$

1

Please continue on next page. ▶

(D) EXPRESS THIS RELATIONSHIP IN SYMBOLS AS AN EQUATION FOR ANY NUMBER N.

$N\times N=Y$

$(N+X)\times(N+X)=Y$

1

Please continue on next page. ▶

Comments on Number Relationships (Grades 7 and 11)

This mathematical exercise required students to demonstrate recognition of a pattern in Part A, then to extrapolate it in Part B, determine how the two equations are related and express the generalized relationship verbally in Part C, and symbolically in Part D.

This exercise appears to be appropriate for both grades 7 and 11. Seventy-six percent of seventh graders and 94 percent of 11th graders in the sample extended the pattern one step in Part A. Fewer extrapolated the relationship to 100 x 100 in Part B. Very few seventh graders successfully expressed the complete relationship in Parts C and D, although some expressed part of the relationship in Part C. As a group, eleventh-grade students performed better than seventh-grade students on all parts of this task. There was little difference between the performance of girls and boys in the sample.

Since the factoring, $n^2 - 1 = (n + 1)(n - 1)$, is familiar in algebra classes, it was important to make sure that experience with algebra was not a sufficient condition for solving the problem. Given the fact that more than 90 percent of the eleventh grade sample reported having taken Algebra 1 and 77 percent reported having had second year algebra, and only 18 percent provided the formula or its equivalent in Part D, it appears that the exercise requires thinking beyond the routine.

The advisory panel recommended this exercise for future use with one change. They suggested that Parts C and D be combined, giving students a choice of expressing the relationship verbally or symbolically. This change would not require pilot testing again.

3. IN A STATE WITH A 5% SALES TAX ON RESTAURANT BILLS, ALFREDO'S RESTAURANT ADDS A 15% TIP AUTOMATICALLY TO THE FOOD COST AND THEN ADDS 5% OF THE TOTAL FOR TAX.

DOMINIQUE'S RESTAURANT ADDS THE 5% TAX TO THE FOOD BILL AND LEAVES THE AMOUNT OF THE TIP TO THE PATRON.

SUPPOSE TWO GROUPS HAD A FOOD BILL OF $100, ONE AT EACH RESTAURANT.

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

____

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

____

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

____

Please continue on next page. ▶

Restaurants
Section 2 - Group
Grade 7M,7S - #4
1M,11S- #3

a) Score 2 pts. for correct answer - the same.
Score 1 pt. for incorrect answer.
Score 0 for no response.

b) Score 2 pts. for correct answer - more.
Score 1 pt. for incorrect answer.
Score 0 for no response.

c) Score 2 pts. for correct answer - less.
Score 1 pt. for incorrect answer.
Score 0 for no response.

Skills involved:

In this exercise students need to extract information from written materials in order to reach a conclusion.

Part a

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

same

②

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

~~[illegible]~~ Same

②

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

The Same

②

Part a.

ELEVENTH GRADE SCORE POINT 2

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

It is the same 2

115
.15
575

105
.15
525
105
1575

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

SAME 2

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

He pays the same as Alfredo's. 2

SEVENTH GRADE SCORE POINT 1

Part a

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

①

LESS

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

①

Dominiques pays less

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

①

It Depends if the costomer at Alfredo's
Know that they dont need to pay a tip

Part a

ELEVENTH GRADE SCORE POINT 1

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

cc : cs

Dominique's - less

a custemor at Alfredo's pays more /

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

The costumer pays more at Alfredo's /

#115.1

(A) THE CUSTOMER AT DOMINIQUE'S LEAVES A 15% TIP FIGURED ON THE FOOD COST PLUS THE TAX. DOES THE CUSTOMER IN DOMINIQUE'S PAY THE SAME, MORE, OR LESS FOR THE TOTAL BILL THAN THE CUSTOMER IN ALFREDO'S FOR THE SAME FOOD COST?

He pays slightly less /

Part B

SEVENTH GRADE SCORE POINT 2

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

MORE

②

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

more

②

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

more

②

Part B

ELEVENTH GRADE SCORE POINT 2

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

The tip is the more at Dominique's

2.

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

[redacted] more

2.

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

MORE

2.

Part B

SEVENTH GRADE SCORE POINT 1

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S? ①

It depends if the person at Dominique's pays more or less then 15%

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S? ①

The Same

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S? ①

It depends on how much tip the coustomer gives.

Part B

ELEVENTH GRADE SCORE POINT 1

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

It is the same.

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

the ~~wa~~ waiter's tip at Dominique's is less

(B) IS THE WAITER'S TIP IN DOMINIQUE'S THE SAME, MORE, OR LESS THAN THE TIP IN ALFREDO'S?

less

Part C

SEVENTH GRADE SCORE POINT 2

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

LeSS

②

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

less

②

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

less

②

Part C

ELEVENTH GRADE SCORE POINT 2

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

LESS 2

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

It would be the [illegible] less 2

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

less 2

Part C

SEVENTH GRADE SCORE POINT 1

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

①

more

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

①

SAme

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

①

more

Part C.

ELEVENTH GRADE SCORE POINT 1

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

same 1

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

SAME 1

(C) IF THE CUSTOMER AT DOMINIQUE'S HAD FIGURED THE TIP ON THE FOOD COST BEFORE TAX, WOULD THE TOTAL SPENT BE THE SAME, MORE, OR LESS?

The total would be the same. 1

Comments on Restaurant (Grades 7 and 11)

This is a mathematical problem that could be solved by logical analysis with an understanding of percents, or by actual computation of percents and comparison of results. Although it was assumed that seventh grade students would have learned to compute percents, the computations were kept simple by using $100 as the base. However, about one-half of the seventh graders did not respond.

Based on the unsatisfactory results and the likelihood that there would be too much disparity in students' experiences with restaurants and tips, the advisory panel recommended that this exercise not be used in the future.

4. Usually your heart beats regularly at a normal rate when you are at rest. Suppose someone asks you the following questions: Does your heart rate go up or down when you exercise? How much does your heart rate change when you exercise? How long does the effect last?

Think about what you would do to find answers to the questions above. What type of experiment would you design to answer the questions? Assume that you have the following equipment available to use: an instrument to measure your heart rate such as a pulse meter, a stop watch, and some graph paper.

Briefly describe how you might go about finding answers to these questions.

► **STOP** Do not continue until told to do so.

Heart Rate
Section 2 - Group
Grade 11M,11S - #4

1) Pertains to scoring for the experimental design (without reference to repeated trials which is scored under 2).

Score 6 pts. for all essential elements:

Baseline - at rest heart rate
Timed exercise
Heart rate measured immediately after exercise
Repeated measurement of heart rate over course of time until normal

(Note: Acceptable repeated measurement statements include those equivalent to: "...continue to take pulse rate until normal.." when the student has indicated that the pulse meter has been strapped on or attached to the subject.)

Score 5 pts. for noting all of the above EXCEPT that the post-exercise measurement is taken only after a specified time lapse or providing a vague post-exercise statement such as "..time myself until normal." without specifying repeated measurements.

Score 4 pts. for noting all of the above EXCEPT that exercise isn't timed.

Score 3 pts. for any experiment that includes baseline measurements and some statements (accurate or inaccurate) about two other variables of the experiment.

Score 2 pts. for any experiment that doesn't include a baseline measurement.

Score 1 pt. for an irrelevant or meaningless experiment or very incomplete experiment that doesn't go beyond exercise.

Score 0 for no response.

2) Pertains to repeated trials:

Score 2 pts. for repeating the experiment using different durations of exercise.

Score 1 pt. for any other indication of a need for repetition.

Score 0 for no mention of repetition.

Skills involved:

In this exercise students need to design a reliable experiment to address a given problem. The student must accomplish this by first identifying key independent and control variables.

ELEVENTH GRADE SCORE POINT 6

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

First measure my heart beat after sitting for an hour or more. Then begin some kind of exercise (running, jumping jacks) for about 10 minutes. During this exercise check every 2min. to see a change in pulse. The stop exercising and relax while periodically checking the pulse every 2min. after. ⑥

Take these results and put them on a graph. Then use that to observe changes in pulse rate. This graph can tell you where the greatest increases and decreases are during the 1 hour period.

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

Step 1 - Take 2 1-MIN. heart rate timings, average the two, graph the results
Step 2 - Excercize for 2 minutes
Step 3 - Take pulse for 1 MIN.
Step 4 - rest one minute, graph pulse ⑥
Step 5 - take pulse for 1 MIN., rest one MIN, etc., alternatly until pulse reads the same as before excercize
Step 6 - graph resuts

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

I would would tare my resting pulse
& record that on the graph paper.
next I would jump rope for 20 sec.
& record my pulse after that. I would
then jump rope for another 20 sec
& record my pulse. I would
continue to do this until the pattern
was clear. Then I would continue
to tare the pulse rate every 20 sec
till it went back to normal

ELEVENTH GRADE SCORE POINT 5

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

FIRST, TAKE SOMEONES HEART BEAT FOR 15 SECONDS WHILE AT REST AND MULTIPLY THAT NUMBER BY 4. PLOT THAT NUMBER ON A GRAPH IN THE COLUMN THAT SAYS "AFTER 0 MINUTES OF RUNNING." NEXT HAVE A PERSON RUN FOR 1 MINUTE AND THEN RECORD HIS HEARTBEAT. AFTER 1 MINUTE REST RECORD IT AGAIN. PUT THE HEARTBEAT THAT THE PERSON HAD AFTER RUNNING IN THE COLUMN THAT SAYS "AFTER TWO MINUTES OF RUNNING." TEST THE PERSON FOR UP TO 5 MINUTES OF RUNNING AND EACH TIME TEST THE PERSON 1 MINUTE AFTER EXERCISING, TOO. ON THE BACK OF THE GRAPH PAPER MAKE ANOTHER GRAPH OF THE HEARTRATES AFTER 1 MINUTE REST.

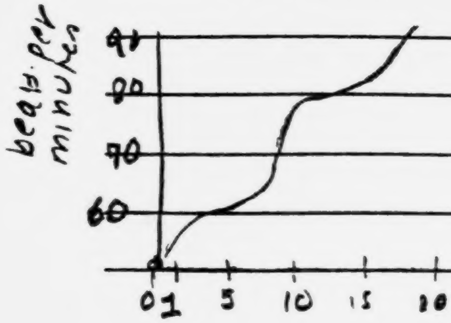
ELEVENTH GRADE SCORE POINT 5

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

(make sure to do same exercise each time)

1) Take heat beat before exercise, mark on graph
2) exercise for 1 minutes. Take heart beat.
3) once heart beat has gone down to normal, exercise 5 minutes Measure heart beat.
4) when heartbeat has gone down to normal, exercise 10 minutes Measure
5) continue process, adding on 5 minutes, If after 7 or 8 times heart beat has reached a plateau (rate for 15 min = 20 min) etc, stop GRAPH results on chart.

⑤



BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

Have a test subject lay at rest Until his heart rate levels off. Then have him jog in place for 1 min. Take his pulse after exercise and then let him rest until his rate goes down to normal. Time how long it takes for his rate to go down after exercise

⑤

ELEVENTH GRADE SCORE POINT 4

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

You would first take the heart rate of a person at rest. Then you would have them run. You would then measure their heart rate again and then once at one-minute intervals, until it was back to normal. Then plot the recorded heart rates on the graph paper.

④

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

First, I would graph how fast my heart is beating in the beginning. Then I would do some type of exercise that would make my heart rate go up. Then I would graph how fast it is going. after that I would graph how long the effect lasted in minutes,

④

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

Does your heart rate go up or down when you exercise — I'd measure my heartbeat when I'm standing still with a pulse meter + and then again after I'd jogged in place for awhile. I'd measure how much it changed by plotting it on graph paper. To find out how long it would last I'd use the stop watch to time how long my heart beat stayed that way and by looking at the pulse meter

④

ELEVENTH GRADE SCORE POINT 3

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

First I would already be relaxed so I would measure my heart rate then. Secand I would do some running then after I set my stop watch for a certai time I would again take my heart rate. I would record this information right after I've done my exercises. when I would get back in my relaxed stage I would take my heart rate after every time I've exercised and compare the changes. ③

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

To find out how fast your heart beat you'd count how many times it beats in one minute without any exercise.

Exercise for one minute then count the beats in one minute.

The effect will last until your heart returns to its normal beat.

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

First you would find the normal rate of heart beats in a certain period of time - say one minute. Then exercise for a period of time & take the rate of heart beat per minute & compare the two answers to see if the rate went up or down. Find the difference between the two numbers to see how much the heart rate changes from exercise And then calculate the amount of time for which your heart rate beats after exercise at that pace. Repeat this series of activites a number of times to find an average. Record each result on graph paper

③

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

I would take a simple exercise such as jogging in place for a minute + then begin 1) time your pulse wait do it again, retime wait + do it one more time + retime it. Compare all times + rates. Then you'd know if there was any change in the rates. ②

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

for 1st question - Do exercise for a specific amount of time (use stop watch to time yourself) Use the pulse meter to test your pulse rate after that specific time. ②

Time how long it takes for your pulse rate to get back to normal.

Plot the results on a graph.

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

First I would exercise and with the pulse meter I would check my pulse to see whether my heart rate increased or not. After that I would take the graph paper and mark on it the amount ②

ELEVENTH GRADE SCORE POINT 1

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

I would get three people The first person would exercise for two hours, rest for one & exercise for two more The second wouldexercise a hour, rest, exercise another hour then rest. The third person would exercise for 3 hours then rest for one ①

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

Well first I would go exercise real good. Then I would get a parent or a friend who knows how to use the instruments that I have to take my measurements. Then I would get him to write down the answers. ①

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

The heart rate increases when one exercises. To verify this, A jogger could be connected to pulse meter to measure the rate increase. ①

ELEVENTH GRADE SCORE POINT 1

BRIEFLY DESCRIBE HOW YOU MIGHT GO ABOUT FINDING ANSWERS TO THESE QUESTIONS.

Step 1 - Take 2 1-MIN. heart rate timings, average the two, graph the results
Step 2 - Excercize for 2 minutes
Step 3 - Take pulse for 1 MIN.
Step 4 - rest one minute, graph pulse
Step 5 - take pulse for 1 MIN., rest one MIN, etc., alternatly until pulse reads the same as before excercize ①
Step 6 - graph resuts

Comments on Heart Rate and Exercise (Grade 11)

This exercise assesses the ability to design a reliable experiment by identifying the key independent and control variables, describing how they would be measured, and indicating how the experiment should be carried out. The problem presented here was originally proposed for a full investigation. This paper and pencil task was included as a prototype for ways to assess thinking skills in biological contexts which pose difficulties for actual implementation in an assessment.

The 30 percent of the sample who scored 0, no response, or 1 may have been hampered by the time limits because this was the last group exercise. Most of the level 1 scores were for very incomplete designs. There were very few meaningless or irrelevant longer designs.

In any future operational use of this task on a large sample, it would be desirable to revise the scoring scheme to distinguish some categories of response that are now combined. For example, it would be desirable to separate out those students who design an experiment using a number of subjects at the same time and those who take their own pulse rate at regular intervals during exercise. Also, some means should be devised for noting whether or not the graph paper was used and, if so, whether a meaningful graph was designed. The exercise apparently worked well and about one-fifth of the students designed an experiment including all essential elements and controls. However, very few mentioned the need for repeated trials, an important element in a reliable experiment. It might be desirable to try to develop a single scoring scheme that combines both parts.

This exercise can be used without change in a future assessment. It is possible that it would be appropriate also for grade 7, but should not be used at that level without pilot testing. Also, this exercise can serve as a prototype for other tasks requiring design of an experiment.

CHAPTER 2

SELF-ADMINISTERED STATION ACTIVITIES

Activity Identification	Grade(s)
Sorting, Classifying	
Birds (classify)	3
Birds (sort)	3
Seeds (classify)	3,7,11
Seeds (sort)	7
Vertebrae (sort)	11
Observing, Inferencing and Formulating Hypotheses	
Sand and Tubes	3,7,11
Rolling Funnels	3,7,11
Wig-Wag	3,7
The Circle Game	3
The Numbers Game	7,11
Water on Brick	3
Balance Scale	7,11
Double Staircase	3,7,11
Tubes and Capillaity	7,11
Conductivity	11
Interpreting Data	
The Gumball Game	3,7,11
Bubbles	3,7,11
Magnet and Compass	11
Designing and Conducting an Experiment	
Sugar Cubes	7
Magnets (strength)	3

STATION 3

How are these birds different?

Here's what you do:

1) Write down three ways that birds A, B, and C are different.

   1. ______________________________
   2. ______________________________
   3. ______________________________

2) Now look at the bird labelled D. Does bird D look most like bird A, bird B, or bird C ?

   ____

Explain what you found:

3) Write down three reasons why you think Bird D looks most like the bird that you have chosen.

   1. ______________________________
   2. ______________________________
   3. ______________________________

Activity Identification: Birds (classify)

Grade(s): 3

Method of Administration: Self-Administered Station Activity

Content Area: Science-Biology

Apparatus required: Four pictures of birds labelled A, B, C, and D that are individually mounted on cardboard. Birds should differ in morphology (type of legs, beak, size, and coloring).

Administration: Administrator should place pictures of birds in front of the student in a standardized position.

Servicing: None required

Birds (classify)
Station A
Grade 3 - station 3

Scoring of the Written Responses

1) Score 1 pt. each starting with code pt. 2 for every plausible listing which specifies ways that birds A, B, and C are different. Score to a maximum of the three best responses.

Score 1 pt. if the student provides an irrelevant response.

Score 0 if the student makes no response. Responses which pertain to incidental aspects (e.g., spots on the pictures) should not be scored.

2) Score 1 point if the student specifies which bird that bird D most resembles. Score 0 if the student makes no response.

3) Score 1 pt. each starting with code pt. 2 for every listing which specifies ways that bird D resembles the bird that has been chosen. Score to a maximum of the three best responses. Score 1 pt. if the student makes an irrelevant response. Score 0 if the student makes no response. Responses which pertain to incidental aspects should not be scored.

Skills involved

In this exercise the student is asked to make a classification of an "unknown" based on observations about a set of stimuli. In order to make this classification the student must make comparisons and contrasts among the "known" stimuli (i.e., the pictures of birds A, B, and C).

Part 1

THIRD GRADE SCORE POINT 4

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. B has a longer neck
2. C has longer legs
3. A has Diffrent color feathers

④.

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. bird A has deafrent colors
2. bird B has a long neck.
3. Bird C has long legs.

④.

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. Their legs are diffrents sizes
2. They have diffrent feathers
3. Their bills are diffrent

④.

Part 1

THIRD GRADE SCORE POINT 3

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. some of them have long legs
2. some of them have short legs
3. and some of them have long beaks

3

---

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. The first one is long
2. The second one has webed feet.
3. the third one has long legs

3

---

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. The form
2. their feet
3. their beaks

3

Part 1

THIRD GRADE SCORE POINT 2

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

②

1. the first one his beak is staight
2. his beake is slanted
3. his beak is pointet

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. They are different colors
2. They are in different places
3. They have different shapes

②

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. a is only white and blue
2. B is only white and brown
3. C is only white

②

Part 1

THIRD GRADE SCORE POINT 1

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. they have diffrent feets
2. one is a duck
3. they don't look a like

①

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

①

1. A likes to live around towns
2. B likes to live in cliffy areas
3. C likes to live around water

1) WRITE DOWN THREE WAYS THAT BIRDS A, B, AND C ARE DIFFERENT.

1. his neck isent as long as the othe
2. his tail is longer.
3. his beck is black.

①

Part 2.

THIRD GRADE SCORE POINT 1

2) NOW LOOK AT THE BIRD LABELLED D. DOES BIRD D LOOK MOST LIKE BIRD A, BIRD B, OR BIRD C ? It looks like bird C ①.

2) NOW LOOK AT THE BIRD LABELLED D. DOES BIRD D LOOK MOST LIKE BIRD A, BIRD B, OR BIRD C ? C ①

2) NOW LOOK AT THE BIRD LABELLED D. DOES BIRD D LOOK MOST LIKE BIRD A, BIRD B, OR BIRD C ? C ①

Part 3

THIRD GRADE SCORE POINT 4

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. They both have long legs ④
2. Their bills ar about the same size
3. same coler feathers

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. because they both have long legs
2. they have long beaks ④
3. and they both are black and white

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. Sharp beak ④
2. long legs
3. both white and black

Part 3

THIRD GRADE SCORE POINT 3

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. his legs
2. and beak
3. and shape

3

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

3

1. They both have long legs
2. They both stand the same way
3. They both have long beaks

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. One reason is that it likes to go on rock
like B,
2. On the head it looks like it has
the same colored feathers.
3. They both have long beaks.

3

Part 3

THIRD GRADE SCORE POINT 2

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. Thier tails are pointed
2. They are all white
3. They both have a lot of black on them.

2

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. They both have a pointed nose
2. They are white
3. And both have long feet

2

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. because they both look tall
2. long legged
3. and white

2

Part 3

THIRD GRADE SCORE POINT 1

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. It stands the same way.
2. Their both standing on rocks.
3. They both have beaks.

①

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. bird d looks the same as bird c
2. amd A
3.

①

3) WRITE DOWN THREE REASONS WHY YOU THINK BIRD D LOOKS MOST LIKE THE BIRD THAT YOU HAVE CHOSEN.

1. It's legs are skinny
2. his beck is ornge.
3. his fethes are the same colores.

①

Comments on Birds(classify) Grade 3

For the first part of this exercise, 65 percent of the students compared and contrasted the birds and specified at least one plausible way that they were different. For the second part, about 45 percent of the students made the best classification for Bird D.

For the third part, again about 65 percent of the students compared and contrasted the birds and specified at least one plausible way that they were similar. About 40 percent of the students discerned more than one plausible similarity.

The advisory panel and the administrators agreed that the exercise was appropriate for third graders. It provided rich, yet manageable stimuli for students to make comparisons and contrasts. The materials also are inexpensive, as well as very easy to set up and maintain. This exercise would be well-suited for any future national assessment.

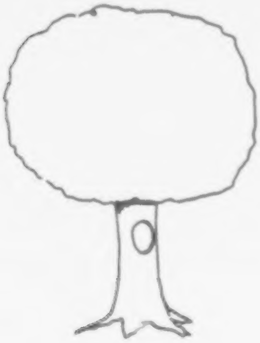
STATION 3

Which birds go together?

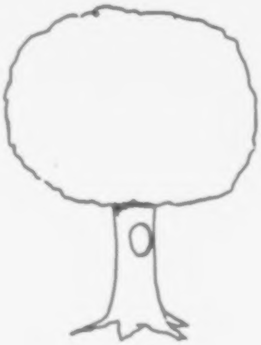
Here's what you do:

1) Write the letters of the birds that go in the two trees. Something must be the same about all the birds in each tree.

You can write the letters of the birds in each of the trees.



Tree 1



Tree 2

Explain what you found:

2) Fill in the spaces below to describe how the birds in each tree are alike.

How are the birds in Tree 1 alike?

____

____

____

How are the birds in Tree 2 alike?

____

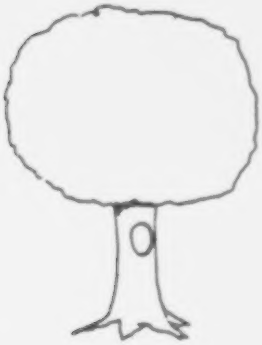
____

____

Please continue on next page. ▶

3) Now put different birds together in each of the two trees.

Something must be the same about all the birds in each tree.



Tree 3

Tree 4

Explain what you found:

4) Fill in the spaces below to describe how the birds in each tree are alike.

How are the birds in Tree 3 alike?

How are the birds in Tree 4 alike?

Activity Identification: Birds (sort)

Grade(s): 3,7,11

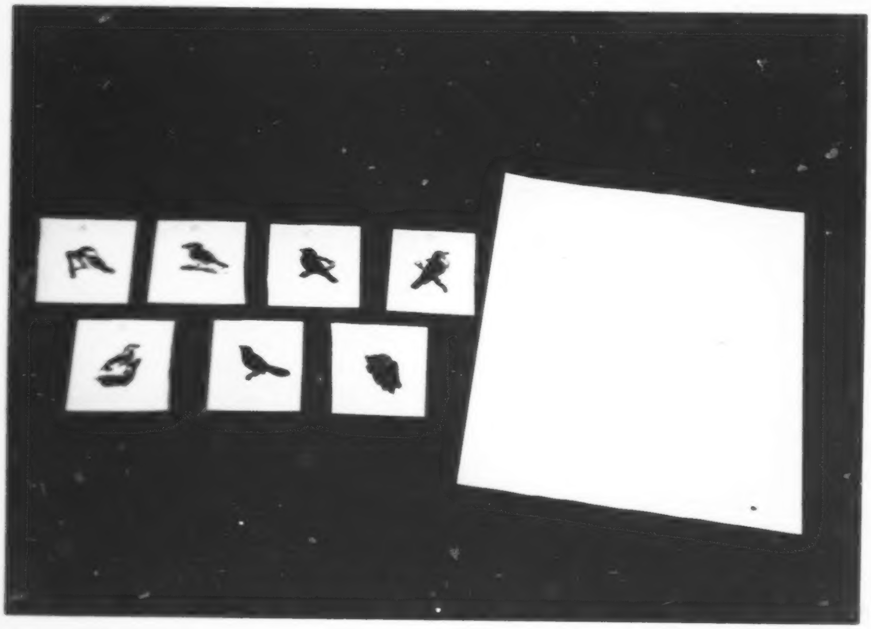
Method of Administration: Self-Administered Station Activity

Content Area: Science-Biology

Apparatus required: Seven photographs of birds labelled A to G that are individually mounted on cardboard. Birds should vary in morphology (color of breast, beak, size, and crest).

Administration: Administrator should place the photographs in front of the student.

Servicing: None required



Birds(sort)
Station B
Grade 3 - station 3

Scoring of the Written Responses

1) Score 2 pts. if the student is able to form two groups of birds which include all birds and no repeats. The birds in each group must be matched on one of the four relevant cues (color, beak, size, and shape). Score 1 pt. if the student either repeats or doesn't use all the birds. Score 0 if the student makes no response.

2) Score 1 pt. starting with code pt. 2 for each plausible listing of how the birds in each group are alike that is consistent with how the student formed each group in 1). Score 1 for an irrelevant listing. Score 0 for no response.

3) Score 2 pts. if the student is able to form two new groups of birds which differ by at least one bird per group from the groups formed in question 1) and are matched on one of the relevant cues. These groups should include all birds and no repeats. Score 1 pt. if the student doesn't use all birds and/or makes repeats. Score 0 if the student makes no response.

4) Score 1 pt. starting with code pt. 2 for each plausible listing of how the birds in each group are alike that is consistent with how the student formed each group in 3). Score 1 pt. for an irrelevant listing. Score 0 for no response.

Skills involved

In this exercise the student is asked to form groups, each based on having one or more of the relevant stimulus attributes in common. In order to form these groups the student must recognize similarities and differences among all the stimuli.

Part 1

THIRD GRADE SCORE POINT 2

1) WRITE THE LETTERS OF THE BIRDS THAT GO IN THE TWO TREES. SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE.

YOU CAN WRITE THE LETTERS OF THE BIRDS IN EACH OF THE TREES.

AB C

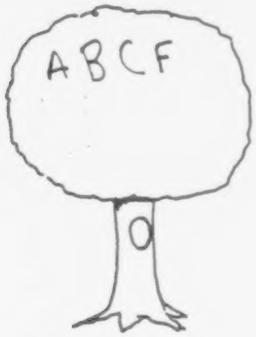
TREE 1

DEFG

TREE 2

1) WRITE THE LETTERS OF THE BIRDS THAT GO IN THE TWO TREES. SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE.

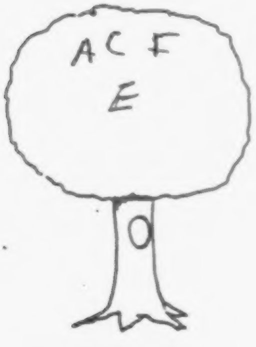
YOU CAN WRITE THE LETTERS OF THE BIRDS IN EACH OF THE TREES.


ABCF

DEG

1) WRITE THE LETTERS OF THE BIRDS THAT GO IN THE TWO TREES. SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE.

YOU CAN WRITE THE LETTERS OF THE BIRDS IN EACH OF THE TREES.


ACF
E

TREE 1

BDG

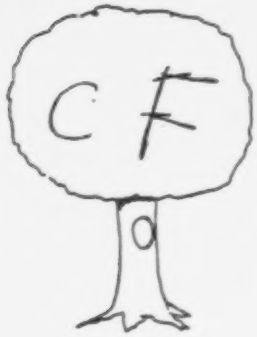
TREE 2

6

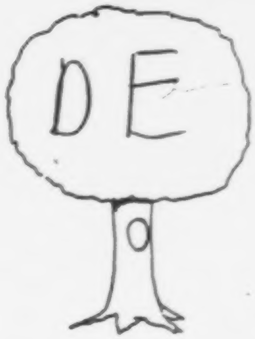
THIRD GRADE SCORE POINT 1

1) WRITE THE LETTERS OF THE BIRDS THAT GO IN THE TWO TREES. SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE. 1

YOU CAN WRITE THE LETTERS OF THE BIRDS IN EACH OF THE TREES.



TREE 1

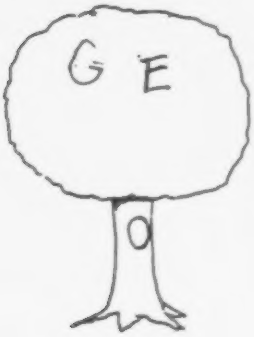


TREE 2

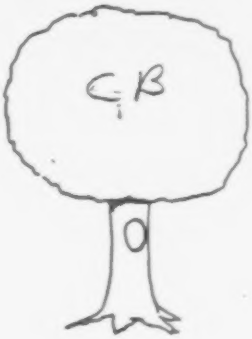
---

1) WRITE THE LETTERS OF THE BIRDS THAT GO IN THE TWO TREES. SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE. 1

YOU CAN WRITE THE LETTERS OF THE BIRDS IN EACH OF THE TREES.



TREE 1

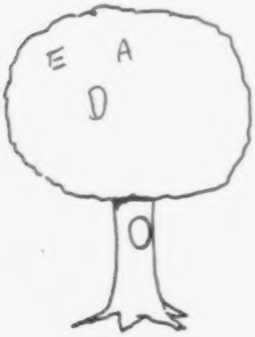


TREE 2

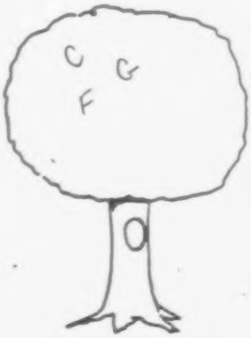
---

1) WRITE THE LETTERS OF THE BIRDS THAT GO IN THE TWO TREES. SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE. 1

YOU CAN WRITE THE LETTERS OF THE BIRDS IN EACH OF THE TREES.



TREE 1



TREE 2

Part 2

THIRD GRADE SCORE POINT 3

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE.

HOW ARE THE BIRDS IN TREE 1 ALIKE?

They are small birds ③

HOW ARE THE BIRDS IN TREE 2 ALIKE?

They are big birds

---

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE.

HOW ARE THE BIRDS IN TREE 1 ALIKE?

Their all like kind of black and they almost have the same head. ③

HOW ARE THE BIRDS IN TREE 2 ALIKE?

The all look brow and yellow like. And their feet are a different color from the other birds.

---

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE.

HOW ARE THE BIRDS IN TREE 1 ALIKE?

They have red and black. ③

HOW ARE THE BIRDS IN TREE 2 ALIKE?

They are brown and they have spots

Part 2

THIRD GRADE SCORE POINT 2

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. (2)

HOW ARE THE BIRDS IN TREE 1 ALIKE?

The birds in tree one have short beaks

HOW ARE THE BIRDS IN TREE 2 ALIKE?

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. (2)

HOW ARE THE BIRDS IN TREE 1 ALIKE?

They all look alike except the color.

HOW ARE THE BIRDS IN TREE 2 ALIKE?

They all hold on to the tree the same.

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. ✓ ②

HOW ARE THE BIRDS IN TREE 1 ALIKE?

All there beaks are almost alike.

HOW ARE THE BIRDS IN TREE 2 ALIKE?

They are all alike in the tails

Part 2

THIRD GRADE SCORE POINT 1

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 1

HOW ARE THE BIRDS IN TREE 1 ALIKE?

Thier all standing on a branch

HOW ARE THE BIRDS IN TREE 2 ALIKE?

Thier all standing on a branch.

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 1

HOW ARE THE BIRDS IN TREE 1 ALIKE?

Cause there both looking up at the sky.

HOW ARE THE BIRDS IN TREE 2 ALIKE?

Cause there both are on a limb.

2) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 1

HOW ARE THE BIRDS IN TREE 1 ALIKE?

The birds in Tree one like to stand on twigs

HOW ARE THE BIRDS IN TREE 2 ALIKE?

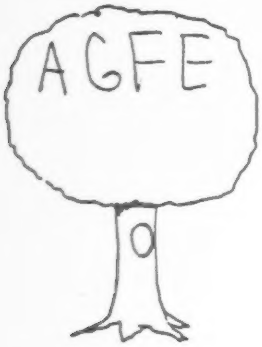
The birds in tree 2 like to peck.

Part 3

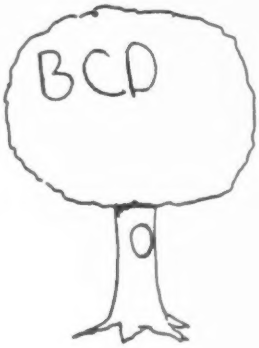
THIRD GRADE SCORE POINT 2

3) SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE.

2



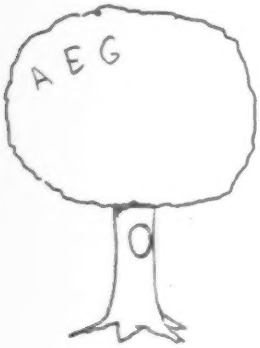
TREE 3



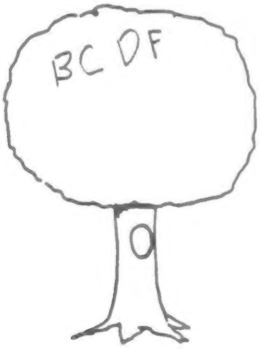
TREE 4

3) SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE.

2



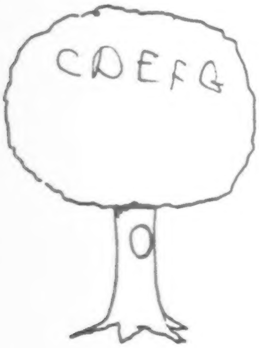
TREE 3



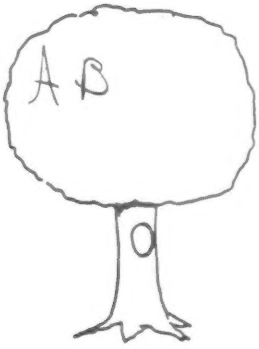
TREE 4

3) SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE.

2



TREE 3

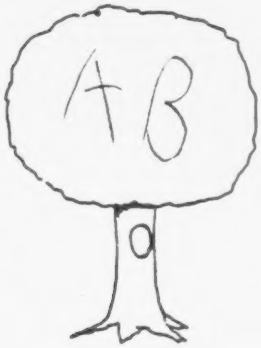


TREE 4

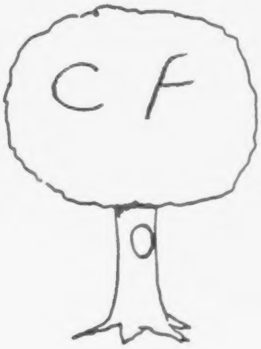
Part 3

THIRD GRADE SCORE POINT 1

3) SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE. 1

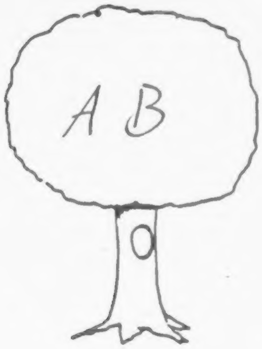


TREE 3

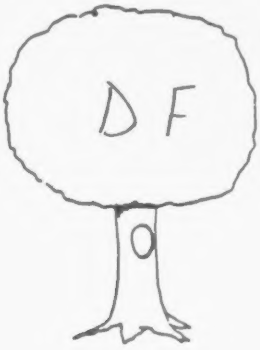


TREE 4

3) SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE. 1

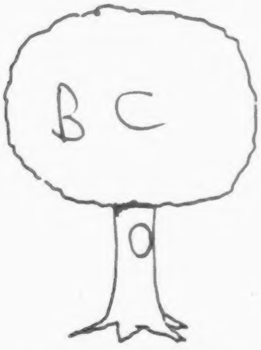


TREE 3

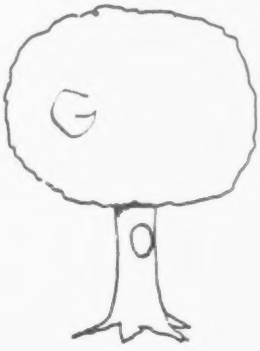


TREE 4

3) SOMETHING MUST BE THE SAME ABOUT ALL THE BIRDS IN EACH TREE. 1



TREE 3



TREE 4

Part 1

THIRD GRADE SCORE POINT 3

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 3

HOW ARE THE BIRDS IN TREE 3 ALIKE?

c, f both have red

HOW ARE THE BIRDS IN TREE 4 ALIKE?

a, b, D, E, G, have black in them

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 3

HOW ARE THE BIRDS IN TREE 3 ALIKE?

They are a little bit skinner,

HOW ARE THE BIRDS IN TREE 4 ALIKE?

are fater,

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 3

HOW ARE THE BIRDS IN TREE 3 ALIKE?

They all have pointed beaks. And they all have a little yellow in them.

HOW ARE THE BIRDS IN TREE 4 ALIKE?

They don't have pointed beaks. And most of the have brown or black or orange feet.

Part 4

THIRD GRADE SCORE POINT 2

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE.

2

HOW ARE THE BIRDS IN TREE 3 ALIKE?

They look like each other

HOW ARE THE BIRDS IN TREE 4 ALIKE?

the Color

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE.

2

HOW ARE THE BIRDS IN TREE 3 ALIKE?

They all have spots

HOW ARE THE BIRDS IN TREE 4 ALIKE?

They all have a branc

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE.

2

HOW ARE THE BIRDS IN TREE 3 ALIKE?

They have Bright and Dull colors.

HOW ARE THE BIRDS IN TREE 4 ALIKE?

They have Bright colors

Part 4

THIRD GRADE SCORE POINT 1

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 1

HOW ARE THE BIRDS IN TREE 3 ALIKE?

spring birds

HOW ARE THE BIRDS IN TREE 4 ALIKE?

woodpecer

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 1

HOW ARE THE BIRDS IN TREE 3 ALIKE?

There all birds

HOW ARE THE BIRDS IN TREE 4 ALIKE?

They are all holding there heads up.

4) FILL IN THE SPACES BELOW TO DESCRIBE HOW THE BIRDS IN EACH TREE ARE ALIKE. 1

HOW ARE THE BIRDS IN TREE 3 ALIKE?

They look alike because they are holding on to the branch.

HOW ARE THE BIRDS IN TREE 4 ALIKE?

They look alike because they are both standing on the branch.

Comments on Birds(sort) Grade 3

In the Birds(sort) exercise, plausible groups of birds could be formed by matching birds on color, beak, size, or shape. To form groups, students would have to understand the problem, observe the birds' similarities and differences, and explain the basis for their groupings. Although 60 percent of the students formed two groups of birds which included all the birds and no repeats, only 21 percent accurately described how just one of their groups were alike and only 22 percent accurately described how both of their groups were alike.

For the third and fourth questions, students were asked to resort the birds to form two new groups each based on new characteristics and then describe the similarities of the birds in each of their new groups. About one-third generated a different sorting, and one-fifth described how the birds in at least one of their new groups were alike.

The advisory panel and the administrators agreed that the exercise needed additional work. The administrators reported that many students did not understand how to place the birds into trees and were confused. A suggested rewording was: "Which birds go together? Which would you put in group 1 and which would you put in group 2?"

Another problem with the exercise was that the colored drawings were too small. Larger colored photographs, such as those used in Birds(classify), would be better stimuli for this exercise.

In spite of these problems, the exercise did show that some students could understand the directions and could sort the birds. The panel liked the idea of a sorting exercise, but recommended that this exercise be revised based on better stimulus materials and directions that eliminated the trees. If the exercise is revised, it would have to be pilot tested before operational use.

STATION 6

WHAT IS THE SAME ABOUT THE SEEDS IN EACH GROUP?

HERE'S WHAT YOU DO:

1) LOOK CAREFULLY AT THE TWO GROUPS OF SEEDS. YOU MAY SMELL THEM AND PICK THEM UP BUT DO NOT TASTE THEM.

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

____

____

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

____

____

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN.

____

____

____

STATION 3

WHAT IS THE SAME ABOUT THE SEEDS IN EACH GROUP?

HERE'S WHAT YOU DO:

1) LOOK CAREFULLY AT THE THREE GROUPS OF SEEDS. YOU MAY SMELL THEM AND PICK THEM UP BUT DO NOT TASTE THEM.

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

____

____

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

____

____

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

____

____

5) NOW LOOK AT THE SEEDS LABELLED X AND Y.

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

SEED X ____________________________________

____

SEED Y ____________________________________

____

Activity Identification: Seeds (classification of unknown)

Grade(s): 3,7,11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Biology

Apparatus required: Containers filled with samples of labelled but unnamed seeds: A = caraway seeds, B = cumin seeds, C = black peppercorns, D = millet seeds, E = fennel seeds, F = all spice, G = white peppercorns, H = yellow mustard seeds, J = fenugreek seeds, X = coriander, Y = barley. For the grade 3 students, only groups 1 and 2 will be used.

Administration: Seeds should be placed into the following groups: Group 1= A,B,E; Group 2= C,F,G; and Group 3= D,H,J. For the grade 3 students only groups 1 and 2 and the unknown X should be set up. For the remaining students, all three groups and both unknowns should be set up. Seeds should be replaced if their level in each dish appears low at the end of an administration. Seeds should be placed back into groups after every administration.

Servicing: None required

Seeds (classification of unknown)
Stations A & B
Grade 3 - station B6
7 - station A3
11 - station A3

Scoring of the Written Responses

(for grade 3)

2-3) Score 1 pt. starting with code pt. 2 for each accurate or plausible statement about how the seeds in each group are the same. Score to a maximum of the three best responses per group. Score 1 pt. if the student provides an inaccurate or irrelevant response. The attribute of smell should be scored as an irrelevant response. Score 0 if the student makes no response.

4) Score 1 pt. starting with code pt. 3 for each accurate or defensible statement about why the student placed seed X in a given group (i.e, Seed X was the same size as the seeds in Group...). Score up to a maximum of the three best responses. Students should place seed X with Group 2. Score 2 pts. for providing a group only. Score 1 pt. if the student provides an inaccurate or irrelevant response. The attribute of smell should be scored as an irrelevant response. Score 0 if the student makes no response.

(for grades 7 & 11)

2-4) Score 1 pt. starting with code pt. 2 for each accurate or plausible statement about how the seeds in each group are the same. Score up to a maximum of the three best responses per group. Score 1 pt. if the student provides an inaccurate or irrelevant response. The attribute of smell should be scored as an irrelevant response. Score 0 if the student makes no response.

6) Score 1 pt. starting with code pt. 3 for each accurate or defensible statement about why the student placed seeds X and Y in a given group. Score up to a maximum of the three best responses for seed X and for seed Y. Scoreable responses for Seed X would include placement with Group 2 because of size and shape or placement with Group 3 because of color and shape. Scoreable responses for Seed Y would include placement with Group 1 because of shape and size or placement with Group 3 because of color and shape. Score 2 pts. if the student provides a group without providing an explanation. Score 1 pt. for an inaccurate or irrelevant response. The attribute of smell should be scored as an irrelevant response. Score 0 if the student makes no response.

Note: Texture and hardness are scoreable attributes.
Group 1: (A,B,E) caraway, cumin, fennel
Group 2: (C,F,G) black peppercorns, allspice, white peppercorns
Group 3: (D,H,J) millet, yellow mustard, fenugreek
Unknown X: Coriander   Unknown Y: Barley

Skills involved

In this exercise students are required to classify an "unknown" based on a set of generalizations about a set of "known" entities. These generalizations are made by making a set of comparisons and contrasts about the set of known entities.

Parts 2-3

THIRD GRADE SCORE POINT 3

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They all look like little lines.

3.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are all balls

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

Their all long and thin

3.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

Their all round.

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

they are all pointed

3.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

they are all round

SEVENTH GRADE SCORE POINT 6

Parts 2-4

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They are all shaped sort of like an oval and have lines

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are all spherical and rigid feeling

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

They are all different shades of yellow

⑥

SEVENTH GRADE SCORE POINT 8

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They are all long and thin. Although they are different colors they all have lines going through them and if they were the same color they would be identical.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are all ball shaped. They all have a distinct strong smell and are dark in color.

⑧

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

They are all very tiny and light in color. They all have a faint smell.

ELEVENTH GRADE SCORE POINT 7 Parts 2--4

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They are all long thin seeds, striped

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

Round seeds

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

Small seeds, light color

(7)

ELEVENTH GRADE SCORE POINT 9

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

Thein oval shaped like small
little watermelons + they are green.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are round and look like
little beads they are also brown.

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

They small like little sand
rocks and are a yellowish brown.

(9)

Parts 2-3

THIRD GRADE SCORE POINT 2

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

they look alike

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

there round

2.

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They all look the same.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are all circles.

2.

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

There all wierd the look
like ichother, but difrent colors

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They all look like beads

2.

SEVENTH GRADE SCORE POINT 2

Parts 2-4

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

they all have the same shape, they smell the same

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

they are all round

2

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

they smell they same

SEVENTH GRADE SCORE POINT 4

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They are all small + look the same except for the color. They are all ovals.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are all round balls.

4

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

H + D are small, tiny balls but J is small tiny squares. They are all small.

Parts 2-3

THIRD GRADE SCORE POINT 1

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1. 1.

They look the same and mell the same

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

they look the same but do not smell the same

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

1 is not like the others

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2. 1.

2 of them smell the same

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They are the same shape and smell bad.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are the same shape a smell bad. 1.

Parts 2-4

ELEVENTH GRADE SCORE POINT 1

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

The seeds are in different stages of development

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

The first cup is older seeds, 2nd cup are medium, and the 3rd cup are new

1

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

They are simalar in color

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

they have the same basic shape.

ELEVENTH GRADE SCORE POINT 3

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

they are all round

3

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

they are all basically the same shape.

ELEVENTH GRADE SCORE POINT 5

2) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 1.

They are all shaped the same long and flat.

3) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 2.

They are all spheres an about the same size.

4) WRITE DOWN WHAT YOU THINK IS THE SAME ABOUT THE SEEDS IN GROUP 3.

They are all lightly colored and about the same shape.

5

Part 4

THIRD GRADE SCORE POINT 3

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN.

#2 because they are circles like group 2. 3

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN.

I would put it in grou p 2. Because it is round. 3

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN.

Group 2. because it Looks like beads 3

SEVENTH GRADE SCORE POINT 2

Parts 5-6

5) NOW LOOK AT THE SEEDS LABELLED X AND Y.

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

SEED Y it smells the same as group 3

2

SEED X it smells and looks the same as group 2

SEVENTH GRADE SCORE POINT 4

5) NOW LOOK AT THE SEEDS LABELLED X AND Y.

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

SEED X It belongs in Group 2 because it is round balls.

4

SEED Y It belongs is Group 1 because it is Oval shape like group 1.

SEVENTH GRADE SCORE POINT 6

5) NOW LOOK AT THE SEEDS LABELLED X AND Y.

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

SEED Y It belongs in group 1 because they are long in size and has the line running through the center.

SEED X It belongs in group 2 because they are little balls and are dark in color.

6

4)‾ NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN.

group 2. Because theare all the same shape and they smell bad. 2

4)‾ NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN. 2

because it is round

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN.

group 2 Becaus they Look the came and smells diffrent 2

ELEVENTH GRADE SCORE POINT 2

Part 6

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

SEED X belongs in group 2 because they are closest in size and shape.

SEED Y belongs in group 1 because they are closest in size and shape.

②

ELEVENTH GRADE SCORE POINT 4

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

SEED X BELONG IN 2 BECAUSE THEY ARE ALSO SPHERICAL AND DARK IN COLOR

SEED Y BELONG IN 3 BECAUSE THE SEEDS IN GROUP 3 DON'T REALLY RESEMBLE EACHOTHER AND SEED Y DOESN'T RESEMBLE GROUP 1 OR 2.

④

ELEVENTH GRADE SCORE POINT 6

6) WRITE DOWN WHY YOU THINK EACH OF THE TWO SEEDS BELONGS IN GROUP 1, 2, OR 3.

⑥

SEED X In 2, because they are round and look like beads: they are brown

SEED Y In 1, because they are like little watermelons + they are a green looking solid.

Part 4

THIRD GRADE SCORE POINT 1

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN. 1

Cup f and cup B

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN. 1

Group 1 Because it has no smell

4) NOW LOOK AT THE SEED LABELLED X. WHICH GROUP WOULD YOU PUT IT IN? WRITE DOWN WHY YOU THINK SEED X BELONGS IN THE GROUP YOU HAVE CHOSEN. 1

Becurs you can't smell no sent

Comments on Seeds(classify) Grades 3, 7, and 11

The kind of thinking called for in this exercise is the same for all three grades, but the task for grade 3 was simplified by using only two groups of seeds and one unknown to be classified into one of them instead of the three groups of seeds and two unknowns used at grades 7 and 11. The task required the students to observe the similarities and differences among the seeds, identify the common characteristics within groups and the differences across groups, and then select the most plausible group for each of the unknowns.

At grade 3, students had trouble identifying ways in which the seeds in a group were alike. Although no one omitted the question, 38 percent did not provide any plausible common characteristic. One-third provided two ways the seeds were alike, but only 1 student gave three ways.

For grades 7 and 11, to achieve the maximun possible score of 10 a student would have to provide, for each of three groups, three ways in which the seeds in that group were alike. Although no one attained the maximum score, 3 percent at each grade attained a score of 9. More than half the grade 7 students and a little less than half the grade 11 students provided at least one plausible characteristic per group, although about one-fifth of the seventh-grade students and one-quarter of the eleventh-grade students did not provide any plausible common characteristic.

More than 90 percent of the students at both grades classified seeds X and Y into acceptable groups, but almost two-fifths at each grade did this without providing any plausible reasons.

In conclusion, the classification of seeds exercise is appropriate for grades 3, 7, and 11. No student at any grade omitted it, although few did very well. It may be desirable to refine the scoring guide to score the responses for each group and for the two unknowns separately.

This task can be used in a future assessment without change.

STATION 3

WHAT IS THE SAME ABOUT THE SEEDS IN EACH GROUP?

HERE'S WHAT YOU DO:

1) LOOK AT THE COLLECTION OF LABELLED CONTAINERS OF SEEDS.

2) PUT THE SEEDS INTO THREE GROUPS. MAKE SURE THAT THERE IS SOMETHING THE SAME ABOUT ALL THE SEEDS IN EACH GROUP. YOU MUST USE ALL THE SEEDS.

WHAT DID YOU FIND:

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: ______________________________

GROUP B: ______________________________

GROUP C: ______________________________

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: ______________________________

____

GROUP B: ______________________________

____

GROUP C: ______________________________

____

Activity Identification: Seeds (sorting)

Grade(s): 7,11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Biology

Apparatus required: Containers filled with samples of labelled but unnamed seeds: A = caraway seeds, B = cumin seeds, C = black peppercorns, D = millet seeds, E = fennel seeds, F = all spice, G = white peppercorns, H = yellow mustard seeds, J = fenugreek seeds.

Administration: Seeds should be placed randomly (not in groups) in front of the student before the onset of each administration. Seeds should be replaced when the level in the container appears low. The letters of each of the groups should face the student.

Servicing: None required

Seeds (sorting)
Station B
Grade 7 - station 3

Scoring of the Written Responses

3) Score 3 pts. if the student forms the following three groups:
   Group 1: A, B, E   Group 2: C,F,G   Group 3: D,H,J
   Score 2 pts. if the student forms any other plausible groups such as grouping by color.
   Score 1 pt. if the student forms incorrect or incomplete groups.
   Score 0 if the student makes no response.

4) Score 1 pt. starting with code pt. 2 for each accurate or plausible statement concerning how the seeds in each group are alike to a maximum of 2 pts. per group. Score 1 pt. if the student provides irrelevant statements for each of the groups. Score 0 if the student makes no response.

Skills involved

In this exercise the student needs to classify a set of stimuli into groups based on their commonalities and differences in attributes. This classification should be based on comparisons and contrasts among these attributes.

Part 3

SEVENTH GRADE SCORE POINT 3

5) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: A B E

GROUP B: C F G

GROUP C: D H J

3

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: D, J, H

GROUP B: F, G, C

GROUP C: B, E, A

3

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: A B E

GROUP B: D H J

GROUP C: C F G

3

Part 4

SEVENTH GRADE SCORE POINT 7

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: Banana-lik shape, with indentions on the side

GROUP B: large, round, dark colored

GROUP C: small, lightly colored

7

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: Long thin seeds

GROUP B: little random and circular colorful seeds

GROUP C: biground dull lookingseeds

7

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: they're all the same shape - small and pointed

GROUP B: they're all the same shape - big, and circular

GROUP C: they're all the same shape, - small, and circular

7

Part 3

SEVENTH GRADE SCORE POINT 2

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS. ②

GROUP A: C, D, G, H

GROUP B: A, F, J

GROUP C: B, E

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: A, B, E

GROUP B: C, G, F, D, H ②

GROUP C: J

---

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: D H J

GROUP B: B G E ②

GROUP C: A F C

Part 4

SEVENTH GRADE SCORE POINT 6

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: small, round seeds.

GROUP B: Large Round seeds. ⑥

GROUP C: thin seed.

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: all the seeds are with section's divided by lines and are in oval shapes with lines. Diagram A →

GROUP B: All the seeds are shaped like baseballs Diagram B → ⑥

GROUP C: These seeds are all very small and smoth in texture Diagram C →

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: all seeds are round and Big

GROUP B: all seeds are long and thin

GROUP C: all seeds are small ⑥

Part 4

SEVENTH GRADE SCORE POINT 5

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: the all look like grass seeds

GROUP B: They were all round balls

GROUP C: they were little and semi round

⑤

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: All the seeds in group A have the same shape (like sun flower seeds)

GROUP B: All the seeds in group B are round

GROUP C: All the seeds in group C are round, and a little smaller than grup B

⑤

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

⑤

GROUP A: They all have a long shape to them. Plus the texture look similar

GROUP B: They all have a round shape They also look as though to have no outside covering

GROUP C: They are all round and seem to have a hard thick covering.

Part 4

SEVENTH GRADE SCORE POINT 4

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: they all shaped alike & look like the same thing but colored

GROUP B: all are very small & have the same colored

GROUP C: all biger seeds than the rest and dark in color

(4)

they all (A, B, C) sound ~~the~~ alike when shakened at each group

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: The seeds are flat and all have the same shape

GROUP B: The seeds are all about the same size and round

GROUP C: All of them are tiny

(4)

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: They are long

GROUP B: They all have a circle on the seed

GROUP C: They are mostly round

(4)

Part 4

SEVENTH GRADE SCORE POINT 3

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: They've got a light color.

GROUP B: They're color is sort of green. ③

GROUP C: They're color is dark.

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: They are all small shaped

GROUP B: They all have the same shape

GROUP C: They all have a big shape ③

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: They are all about the same size and shape.

GROUP B: They are all round and about the same size ③

GROUP C: They are all small and about the same shape

SEVENTH GRADE SCORE POINT 2

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: The seeds are shaped pretty much the same. ②

GROUP B: The seeds are all different colors, and they are shaped like balls.

GROUP C: This group of seeds are only one group. I found no similarity between these seeds and any of the others.

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: The colors are all the same, and the seeds all have a spherical shape ②

GROUP B: They all mostly the same color.

GROUP C: The seeds are all stringy, or long.

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: They are all round. ②

GROUP B: They are all Kind of brown.

GROUP C: Both have the same shape.

Part 3

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: ABC

GROUP B: DEF

GROUP C: GHI

①

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: E, H, C, D, G

GROUP B: J

GROUP C: E, A, B

①

3) WRITE THE LETTERS OF THE SEEDS IN YOUR THREE GROUPS.

GROUP A: A C H

GROUP B: E F J

GROUP C: B G D

①

Part 4

SEVENTH GRADE SCORE POINT 1

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: they are all shaped the same way.

GROUP B: They are all shaped the same way.

GROUP C: they are all the nearest to the same size

①

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: They smell spicey

GROUP B: sweet, pleasing, smell

GROUP C: They have no smell

①

4) WHAT IS THE SAME ABOUT THE SEEDS IN EACH OF YOUR THREE GROUPS?

GROUP A: The seeds in incup A and B look very much alike except one is lighter

GROUP B: The only very similar thing is cup D and F are both Sphere shaped

GROUP C: cup G and H are both sphere shaped and cup H and J have the same color

①

Comments on Seeds(sort) Grade 7

In this exercise, seventh-grade students were asked to sort a collection of seeds into three groups and then describe the similarities among the seeds in each of their groups. This required close observaton of the characteristics of the seeds to identify their similarities and differences in order to form the groups. Every student divided the seeds into three groups, and 84 percent formed the groups with the more important common characteristics. Only ten percent did not cite any plausible way in which the seeds in any group were alike, and 21 percent provided two plausible statements for each group.

This exercise can be used in a future assessment without change. However, it may be desirable to refine the scoring guide to distinguish between those students who provided one similar characteristic for each group and those who provided two or more characteristics for one group and none for another.

STATION 3

WHAT IS THE SAME ABOUT THE BONES IN EACH GROUP?

HERE'S WHAT YOU DO:

1) LOOK AT THE COLLECTION OF LABELLED BONES. THESE BONES ARE FROM THE BACKBONES OF DIFFERENT ANIMALS.

2) PUT THE BONES INTO THREE GROUPS. MAKE SURE THAT THERE IS SOMETHING THE SAME ABOUT ALL THE BONES IN EACH GROUP. YOU MUST USE ALL THE BONES.

WHAT DID YOU FIND:

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: ______________________________

GROUP B: ______________________________

GROUP C: ______________________________

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: ______________________________

____

GROUP B: ______________________________

____

GROUP C: ______________________________

____

Activity Identification: Vertebrae (grouping)

Grade(s): 7,11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Biology

Apparatus required: Eleven bones labelled A-L as follows:

A = Lumbar dog
B = Cervical rabbit
C = Thoracic dog
D = Thoracic cat
E = Lumbar dog
F = Atlas dog
G = Cervical rabbit
H = Cervical dog
J = Lumbar rabbit
K = Thoracic rabbit
L = Lumbar rabbit

Administration: Bones should be randomly placed (not in groups) with the labels facing the students before the onset of each administration.

Servicing: Minor gluing if necessary

Vertebrae (Grouping)
Station B
Grade 11 - station 3

Scoring of the Written Responses

3) Score 4 pts. if the student forms the following 3 groups:

A	E	J	L	(lumbar)
B	F	G	H	(cervical)
C	D	K		(thoracic)

Score 3 pts. if the student forms the correct groups except for the atlas.

Score 2 pts. if the student forms one correct group.

Score 1 pt. if the student forms any three groups different from those specified above.

Score 0 if the student makes no response.

4) Score 1 pt. each starting with code pt. 2 for an accurate or plausible statement concerning how the bones in each group are alike. Score to a maximum of the two best responses for each of the three groups of bones. Score 1 pt. if the student provides an inaccurate or irrelevant set of responses only. Score 0 if the student makes no response.

Skills involved

In this exercise the student needs to classify a set of unfamiliar materials into groups based on their commonalities and differences in attributes. This classification should be based on comparisons and contrasts among these attributes.

Part 3

ELEVENTH GRADE SCORE POINT 4

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

T GROUP A: C, D, K

L GROUP B: A, E, J, L

C GROUP C: B, F, G, H

④

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

T GROUP A: C, K, D

L GROUP B: A, E, L, J

C GROUP C: B, G, H, F

④

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

L GROUP A: A J L E

T GROUP B: D, C, K

C GROUP C: F. B. H. G

④

Part 3

ELEVENTH GRADE SCORE POINT 3

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

L GROUP A: A E,F,J L

C GROUP B: B,G,H

T GROUP C: C,D,K

3

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: D, C, K, F

GROUP B: H,B,G

L GROUP C: E, A, L, J

3

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: D,K,C,F

L GROUP B: A,J,L,E

GROUP C: B,G,H

3.

Part 3

ELEVENTH GRADE SCORE POINT 2

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: B, G

T GROUP B: C, D, K

GROUP C: A, E, F, H, J, L

②

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

T GROUP A: C, D, K

GROUP B: A, E, H, J, L

GROUP C:

②

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: J, L

GROUP B: A, B, E, F, G, H

T GROUP C: C, D, K

②

ELEVENTH GRADE SCORE POINT 1

Part 3

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: A, E, C, K, P, O

GROUP B: B, G

GROUP C: K, J, F, L

①

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: A, E, F

GROUP B: H, J, J

GROUP C: B, C, D, G, K

①.

3) WRITE THE LETTERS OF THE BONES IN YOUR THREE GROUPS.

GROUP A: E, J, L

GROUP B: G, B, K, ID

GROUP C: 4, C, J, A

①.

Part 4

ELEVENTH GRADE SCORE POINT 6

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: all have one long piece projecting; all have a hole in middle of central part ✓✓

GROUP B: all have a central large area with hole and two long pieces projecting out ✓✓

GROUP C: all are essentially a central structure with a hole in the middle and no long thin pieces projecting off them ✓

6

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: All of the bones have a little arm sticking out, and have a hole in the main body ✓✓

GROUP B: All have two arms sticking out the sides and one big ridge on top (if you hold it right) ✓

GROUP C: All three have "wings" on the top with a faint bone ridge (faint on #) ✓

6.

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: One hole and many long bones ✓✓

GROUP B: One hole and one major long bones ✓✓

GROUP C: Many holes (at least three) ✓

6

ELEVENTH GRADE SCORE POINT 5 Part 4

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: All these bones are formed close together w/ nothing extending very far (hole through the center) 5

GROUP B: All these bones have a main body and one long part extending like a sword (hole the main body)

GROUP C: all thes bones have two extended limbs that stick out like a in a wishbone form. The main body part looks more solid and has less holes in it than the other groups

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: "They all have three "pitchFork" bone on top 2 bones sticking out sides of lower part hole in middle

GROUP B: one long bone connected to a oval part 5

GROUP C: they all shaped like ovals with wholes in it

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: If you hold them a certain way, and look through the hole, they all have a piece on each side that portrudes

GROUP B: If you look through the hole there are 5 portrusions; one on top, and three on the side 5

GROUP C: If you look through the hole they all have one long piece that portrudes and 2 small ones on the side

Part 4

ELEVENTH GRADE SCORE POINT 4

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: These bones have many small protrusions but none of them are outstanding

GROUP B: These bones all have one long protrusion which stands out.

GROUP C: These bones have two outstanding protrusions of various lengths and widths.

④

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: They have the same type of structure and each one has one large hole and five small ones, one on each side of the large hole

GROUP B: They each have one long bone sticking out from the "center"

GROUP C: Each of these bones has five "legs" – bones sticking out from the main part which forms a sort of stand.

④

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: They are tall, have a main part supported by 3 small, close bones, and two big, long bones.

GROUP B: These all have a main part, a hole in the and are supported by many legs, in a rough triangular pattern.

GROUP C: These all have a main part with a hole, 2-5 bones sticking out, and one main, long bone extending outwards

④

Part 4

ELEVENTH GRADE SCORE POINT 3

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: there all have prominent flat, wide growths, opoued to ~~[illegible]~~ pointu bone

GROUP B: ✓ there all have one or two thin pieces of bone that stick out (3).

GROUP C: ✓ there are a combination of group A + B - they contain 2 or 3 thin pieces of bone that stick out, but they also contain a flat growth of bone on top

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: ✓ THE BONES IN THIS GROUP HAVE 2 LARGE PIECES OF BONE THAT SHOOT OFF ONE SIDE.

GROUP B: ✓ THESE BONES HAVE ONE LONG PIECE THAT SHOOTS OFF FROM ONE SIDE (3).

GROUP C: THESE BONES HAVE NO DISTINCTIVE BONY PROTRUSIONS,

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: ✓ Basic tripod shape with hollow tube like centers. Smaller legs of two surrounding one leg^{2} Stool like planes on eitherside.

GROUP B: Vertebraelike shapes. many varied protrutions except for E (3)

GROUP C: ✓ Same basic pipelike shape long protruding part with empty center cavity. Two groups of shorter protrusions almost perpendicular to the longest.

Part 4

ELEVENTH GRADE SCORE POINT 2

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: They are the most distinctive and have the lowest park parts.

GROUP B: They only have middles. Their fronts and ends are much shorter than the others. ②

GROUP C: They have the longest front but the shortest backs.
✓

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: they all have a cavity in the middle with "wings" which stick out. Only F doesn't have the "tail" but it has a large cavity and the "wings"

GROUP B: All of the bones have the same shape except H is larger. They have the two bones coming out in the front and in the back - large cavity w/ two smaller cavities on the sides ②

GROUP C: Only 1 cavity - all have 2 long bones in front
✓

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: 1 single piece jutting out, F doesn't, but it has the other qualities of A. maybe its broken

GROUP B: 2 pieces jutting out, stands upright on 5 "Legs" 2 front, 3 in back ②
✓

GROUP C: 4 "legs" with one roundish middle piece

ELEVENTH GRADE SCORE POINT 1

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: They all have a long sort of extended bone from all of them.

GROUP B: They are small + both have the same shapes.

GROUP C: Some have flat extended parts + some have 3 prongs.

①

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS? As there are more than 3 different structures.

GROUP A: In group A all of the bones are large. Two have similar structures, but F is an odd ball

GROUP B: In Group B, all of bones are medium sized. Two have similar structures but H is an odd ball.

GROUP C: Group C contains the smallest bones. C, D, and K have similar structures. So do B and G but otherwise they're different.

①.

4) WHAT IS THE SAME ABOUT THE BONES IN EACH OF YOUR THREE GROUPS?

GROUP A: 3 have the same shape but the 4th one has holes like the others do

GROUP B: same basic shape they all look the same, but in different sizes

GROUP C: same shape different sizes

①.

Comments on Vertebrae(sort) Grade 11

In this exercise which called for students to form groups of vertebrae, the students had to observe the bones' similarities and differences and report their sorting results. Plausible groups of vertebrae could be formed by matching the bones on external morphological characteristics, such as number of projections, size of projections, number of foramen, size of centrum, or general shape. The best grouping would contain thoracic, cervical, and lumbar vertebrae in their respective groups. The Atlas is a slightly atypical cervical vertebrae, therefore, it was anticipated that some students would find it a problem.

For the third part of this exercise, 54 percent of the students were able to correctly place the thoracic, cervical, and lumbar vertebrae in their respective groups. Another 20 percent of the students correctly grouped all the vertebrae, but misplaced the Atlas. A valid statement distinguishing at least one feature of each group of the vertebrae was made by 67 percent of the students for part four of the exercise.

Based on these results, it was the consensus of the advisory panel that this exercise is suitable for eleventh graders and also would be suitable for seventh graders. Also, the administrators reported that the students appeared to like the challenge of sorting the vertebrae. The materials for this exercise are fragile, but small and very easy to set up. With sufficient lead time, the bones are easy to obtain. This exercise is appropriate for any future national assessment at eleventh grade and probably at seventh grade.

STATION 2

HOW DID THE AMOUNT OF SAND IN THE TUBES AFFECT THE TIME IT TOOK FOR THEM TO ROLL DOWN THE SLOPE?

HERE'S WHAT YOU DO:

1) ROLL TUBES A, B, AND C DOWN THE SLOPE ONE AT A TIME.

WHAT DID YOU FIND:

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A ____________________.

3) TUBE B ____________________.

4) TUBE C ____________________.

NOW ROLL TUBE D DOWN THE SLOPE.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

____

____

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

____

____

____

Activity Identification: Sand and Tubes

Grade(s): 3,7,11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Physics

Apparatus required: Three identical capped plastic test tubes labelled A, B, and C, each filled with sand to different levels; one empty capped plastic test tube labelled D; wooden or plastic incline with START clearly printed on the top of the incline; paper and pencils.

Administration: Tubes should be placed in a suitable location where they can't roll into one another. Tube D should be placed close by but physically distinct from the other three tubes. The incline may be placed on the floor.

Servicing: Tubes should be stood up after every administration to level off the sand.

Sand & Tubes
Station A
Grade 3 - station 2
7 - station 2
11 - station 2

Scoring of the Written Responses

2-4) Score 4 pts. for a statement or set of statements which accurately assess the relationship between the speed down the slope and the amount of sand in the tube (i.e., the more sand in the tube, the faster it rolls).

Score 3 pts. for statements which only note how the tube rolled down the slope (e.g., the tube rolled fast) or how much sand was in the tubes (e.g., the tube had a little sand in it).

Score 2 pts. for an inaccurate statement about the relationship between the speed down the slope and the amount of sand in the tube.

Score 1 pt. for an irrelevant or incorrect statement or set of statements.

Score 0 if the student makes no response.

5) Score 2 pts. for an accurate statement or set of statements about how tube D rolled down the slope compared to the other tubes. Score 1 pt. for an irrelevant or incorrect statement about how tube D rolled down the slope. Score 0 if the student makes no response.

6) Score 3 pts. if the student notes two or more of the following: 1) that sand slowed down the partly filled tubes, 2) that sand could not roll around in the full tube and therefore makes the tube roll faster, or 3) absence of sand made the tubes roll faster.
Score 2 pts. if the student notes one of the above. Score 1 pt. if the student's response is irrelevant or doesn't provide an explanation.

Score 0 if the student makes no response.

Skills involved

In this exercise the student is to formulate a hypothesis or set of hypotheses to account for her or his observations. In order to formulate this hypothesis the student must make comparisons and contrasts between specific observations (i.e. the different tubes).

THIRD GRADE SCORE POINT 4

Parts 2-4

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

④

2) TUBE A Tube A was the fastest because it had the most sand.

3) TUBE B Tube B was fast and slow because it had an inch less than Tube A.

4) TUBE C Tube C was the slowest because it had an inch less than Tube B.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

④

2) TUBE A rolled the fastest with most sand.

3) TUBE B rolled second fastest with second most sand

4) TUBE C rolled slowest with third most sand.

SEVENTH GRADE SCORE POINT 4

Parts 2-4

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

④

2) TUBE A Since the weinit in tube A was heavy it rolled gaster than any on them.

3) TUBE B ~~The Tube B wasn't as heavy as t A~~ it didnt rolled as fast.

4) TUBE C Tube C was very light it didnt roll hardly any & once at the bottom of the hill it stopped.

NOW ROLL TUBE D DOWN THE SLOPE.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

④

2) TUBE A The amount of sand in the tube made it go faste than wet

3) TUBE B Because of the tape on the tube it enable the tube to move at a f and the tape is a

4) TUBE C rolled slow because it had sand and no tape was on it therefore no fiction was relea

NOW ROLL TUBE D DOWN THE SLOPE.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

④

2) TUBE A Tube A was the fastest the sand didn't move.

3) TUBE B Faster than tube C but slower than A because the sand had to shift the slowing. the tube do

4) TUBE C Slowest because the sand had to shift the most

Parts 2-4

Eleventh Grade Score Point 4

Write down in the spaces below how the amount of sand in each of the tubes affected how fast it rolled down the slope. Tell how fast each tube rolled compared to the other tubes.

4

2) Tube A This was the fastest. The more sand in the Tube the faster it rolls.
3) Tube B This was second fastest.
4) Tube C This was the third fastest.

Write down in the spaces below how the amount of sand in each of the tubes affected how fast it rolled down the slope. Tell how fast each tube rolled compared to the other tubes.

4

2) Tube A more sand - more acceleration.
3) Tube B less sand - slower acceleration.
4) Tube C still less sand - slower acceleration

Now roll tube D down the slope.

Write down in the spaces below how the amount of sand in each of the tubes affected how fast it rolled down the slope. Tell how fast each tube rolled compared to the other tubes.

4

2) Tube A More sand, therefore it rolled fast Mass the great-
3) Tube B A little less it rolled at a steady pace
4) Tube C Less than the others slower pace - Mass less than.

THIRD GRADE SCORE POINT 3

Parts 2-4

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A fastest.
3) TUBE B middle. ③
4) TUBE C slowest.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A fastest.
3) TUBE B in between. ③
4) TUBE C slower.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A Faster than the others.
3) TUBE B a little slower than a. ③
4) TUBE C a lot slower than A and B.

Parts 2-4

SEVENTH GRADE SCORE POINT 3

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A A rolled fast.

3) TUBE B B rolled a little slower.

4) TUBE C C rolled slow.

3

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A went fastest.

3) TUBE B went 2nd fastest.

4) TUBE C was slowest.

3

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

3

2) TUBE A rolled faster than both B&C.

3) TUBE B rolled slower than A but faster than C

4) TUBE C rolled slower than both A&B.

Parts 2

ELEVENTH GRADE SCORE POINT 3

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

③

2) TUBE A most sand \ faster than B and C

3) TUBE B less sand than A, more than C \ faster than C

4) TUBE C least sand \ slowest.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A rolled fastest.

3) TUBE B rolled second fastest.

4) TUBE C rolled slowest..

③

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A filled → rolled fast.

3) TUBE B almost filled → rolled medium.

4) TUBE C almost ½ filled → rolled slow.

③

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A This tube was the slowest. ②.
3) TUBE B And this tube was 2 slowest
4) TUBE C This tube was 3 slowest the more sand the slower the tube rolls.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A Fast.
3) TUBE B a little bit slower. ②
4) TUBE C and a little bit slower.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A fast
3) TUBE B slower ②.
4) TUBE C slower

Parts 2-4

THIRD GRADE SCORE POINT 1

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A 3

3) TUBE B 4 ①

4) TUBE C 2

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A fast

3) TUBE B fast ①

4) TUBE C Slow

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES. ①

2) TUBE A It looked like it hadalittleless.

3) TUBE B When it rolled it looked like itwas full.

4) TUBE C When it rolled the sand was rollingtoo.

Parts 2.-4

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A It went slow ①.
3) TUBE B It went a little faster .
4) TUBE C I went faster than both .

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A It went kind of fast. .
3) TUBE B It went faster than A . ①.
4) TUBE C It went faster than A+B .

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES. ① .

2) TUBE A It was down the slope in 5 seconds
3) TUBE B It was down the slope in 4 seconds
4) TUBE C It was down the slope in 7 seconds

Parts 2-4

ELEVENTH GRADE SCORE POINT 1

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A Fast.
3) TUBE B faster. ①
4) TUBE C fastest.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A Rolls down slanted, hits harder.
3) TUBE B Slants more. hits hard. ①
4) TUBE C Slow. Slants alot more.

WRITE DOWN IN THE SPACES BELOW HOW THE AMOUNT OF SAND IN EACH OF THE TUBES AFFECTED HOW FAST IT ROLLED DOWN THE SLOPE. TELL HOW FAST EACH TUBE ROLLED COMPARED TO THE OTHER TUBES.

2) TUBE A Harldly Affected it at all.. ①
3) TUBE B had a similar response.
4) TUBE C was bogged down and rolled slower.

THIRD GRADE SCORE POINT 2

Part 5

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

Tube D rolled down the Fastest

②

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

②

It went the fastest.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

It was the fastest tube ②

Part 5

NOW ROLL TUBE D DOWN THE SLOPE.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

Tube D rolled at about the same speed as A but it rolled faster than B&C.

②

NOW ROLL TUBE D DOWN THE SLOPE.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

It went much faster than A, B, or C

②

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

It rolled much faster since it had no matter or sand inside it.

②

Part 5

ELEVENTH GRADE SCORE POINT 2

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS? ②

D was about the same speed as A

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS? ②

It rolled as fast as tube A.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS? ②

D rolled approxamatly the same as A

Part 5

THIRD GRADE SCORE POINT 1

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

it went down like Tube C. ①

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

good ①

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS? ①

It wasnt different from the others,

SEVENTH GRADE SCORE POINT 1 Part 5

NOW ROLL TUBE D DOWN THE SLOPE.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

It went up higher ①

NOW ROLL TUBE D DOWN THE SLOPE.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

it don't make the much nois going down the sloop. ①

NOW ROLL TUBE D DOWN THE SLOPE.

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS?

D it was down the slope in 2 seconds plus it had no sand. ①

Part 5

ELEVENTH GRADE SCORE POINT 1

5) HOW DID TUBE D ROLL DOWN THE SLOPE COMPARED TO THE OTHERS? ①

D rolled much slower compared to the others. also, much noisier.

THIRD GRADE SCORE POINT 2 Part 6

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

because it didn't have any other wight to carry. ②

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It rolled fast because it did not have any thing in it ②

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

Because it was lighter than the others. Even after D left the slope it kept on rolling ②

Part 6

SEVENTH GRADE SCORE POINT 3

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

D rolled faster than B & C because there was nothing inside of it to slow it down. D rolled at about the same speed as A because A was filled and was pulled completely down by gravity and D didn't have anything in it so it went just as fast.

3

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It went fastest because the ones with sand pulled to the side because the sand was on that side but tube D could just roll right down the center of the ramp,

3

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It was faster than B+C becaus there was no sand to shift. It was slower than A because it was lighter

3

Part 6

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It rolled the way itdidbecause it didn't have any sand in it. The more sand that is in the tube the slower it rolls.

②

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

②

Because it had no sand in it and therefore since matter is a pull on gravity it rolled faster

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

Because Tube D did not have any sand in it and others did like a, B, C

②

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

I think that D and A were similar because they both had solid volumes of a content, there wasn't a lot of room for the extra sand to roll ③

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

B and C had to go slower so the sand could shift. A was filled all the way so the sand didn't move much, and in D there was no sand to slow it down ③

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES. ③

It was balanced like A was, meaning that tube A was full of sand and tube D was empty. The other tubes were slower because they were half Filled with sand which made them off balance because everytime the tube turned over the loose sand would turn over slowing the tube down when it hit the opposite side. There was no extra space for sand to halt tube A and no sand at all to halt tube D.

Part 6

ELEVENTH GRADE SCORE POINT 2

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It had no weight so it started fast and could be pushed by the air when the others couldn't because of their weight.

(2)

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

tube D rolled as fast as A because the other tubes were only partially filled with sand, this made them slower.

(2)

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

Tube D rolled as fast as Tube A because it had no weight in it, while Tubes B,C didn't have as much weight as Tube A so they rolled slower.

(2)

Part 6

THIRD GRADE SCORE POINT 1

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It like the others exept it didnt have any

①

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

D rolled faster than others.

①

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

D has * alot of air in it where c had the same amount as D Did.

①

Part 6

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

D had no sand which bonced higer because it hat no sand to get up the hill ①

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

it rolled liter and solfte fast down the slope and dn't hit the box that hard. ①

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It had less sand ①

Part 6 T.

ELEVENTH GRADE SCORE POINT 1

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES.

It seems to be a matter of balance as to how fast each cylinder rolls ①

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES. ①

Tubes A + D rolled the same empty + full. I guess that's what the instructions meant.

EXPLAIN WHAT YOU FOUND:

6) EXPLAIN WHY TUBE D ROLLED THE WAY IT DID COMPARED TO THE OTHER TUBES. ①

The mass I think was equal to the volume, therefore the gravity moved it very rapid.

Comments on Sand and Tubes (Grades 3, 7, and 11)

This activity required students to infer the relationship between amount of sand in each tube and how fast it rolled by rolling each tube down an incline and observing the results. Students were asked to note the results, and to formulate a hypothesis about why tube D (the empty tube) rolled the way it did. While this activity was well received, staff and consultants had numerous suggestions for revision. The apparatus seems extremely well suited to making observations and drawing conclusions about the relationship between the amount of sand in the tube and how fast it rolls. Yet, no third graders and only a few seventh and eleventh graders explicity noted this relationship. This question, in contrast to the Wig-Wag question discussed later in this section, did not explicitly ask students to state the relationship or provide a single response space for a summary statement. It was agreed by staff and consultants that the assessment should contain a range from explicitly stated questions to questions in which the students are required to infer the relationship based only on their observation. In the latter type, however, care must be taken that students are not misdirected as might have been the case with Sand and Tubes.

Some consultants felt it was inappropriate to ask why tube D (the empty tube) should roll differently from the tubes with sand because that is an extremely difficult question. Others felt such a question would be good, as it would require students to develop a hypothesis. Suggestions for questions that could be asked about tube D included predicting how the tube might roll compared to the previous tubes, or hypothesizing about how much sand was in the tube based on how fast it rolled. The compromise might be to have students base their hypothesis on their observation and accept all plausible hypotheses.

Finally, it was suggested that this activity might be group or computer administered. This would be more cost effective and might provide a way to ensure that students do not revise (erase) their hypotheses about tube D based on their actual observations. If the apparatus is used, the tubes should be made of plastic instead of glass.

In summary, the idea and apparatus for Sand and Tubes is appropriate for use in an assessment at all three grade levels. The format of parts 2-4 should be revised so that it does not discourage students from articulating a single relationship between the amount of sand and how fast the tubes roll. The questions should also capitalize on the apparatus and ask students to predict or hypothesize about tube D. A question about why tube D does not fit the established pattern would be acceptable, if there is a way to record students' initial hypothesis about tube D. The consultants seemed quite confident that students would erase these hypotheses if they differed from their subsequent observations. This activity should be retained and revised. It could be a computer simulation or administered using a computer plus a videodisc, and, if not that, perhaps group administration with much larger tubes for demonstration by the administrator.

STATION 2

DO THE CAN AND THE FUNNELS ROLL DIFFERENTLY AT POINT A? AT POINT B?

HERE'S WHAT YOU DO:

1) PUT THE CAN ACROSS THE TWO PIECES OF WOOD AT POINT A, LET GO AND WATCH WHAT HAPPENS.
2) PUT THE CAN AT POINT B, LET GO AND WATCH WHAT HAPPENS.
3) PUT THE TWO FUNNELS THAT ARE STUCK TOGETHER AT POINT A, LET GO AND WATCH WHAT HAPPENS.
4) PUT THE TWO FUNNELS AT POINT B, LET GO AND WATCH WHAT HAPPENS.

WHAT DID YOU FIND:

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

____

____

____

____

____

Activity Identification: Rolling Funnels

Grade(s): 3,7,11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Physics/Mathematics-Geometry

Apparatus required: A double cone made with two identical plastic funnels; a wooden board with two diverging rails and points at opposite ends labelled A and B; an empty tin can.

Administration: Administrator should place the board, can, and funnels on a flat surface (table top) next to the diverging rails. The can and the funnel should be placed in a stand-up position.

Servicing: None required

Scoring Guide

Rolling Funnels
Station B
Grade 3 - station 2
7 - station 2
11 - station 2

Scoring of the Written Responses

5) Score 1 pt. each starting from score pt. 2 for each accurate statement about the ways the can and the funnels roll differently for a maximum of 3 pts. Scoreable responses would include the following: 1) the funnels roll uphill at point B, 2) the funnels do not roll at point A, or 3) the can doesn't roll at point B.

Score 1 pt. for an inacurate or irrelevant response.

Score 0 if the student makes no response.

Skills involved

In this exercise the student must make comparisons and contrasts between specific observations (i.e., the can and the funnels).

THIRD GRADE SCORE POINT 4 Part 5

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

the can rolled and hit the table. The funnel did n't roll for A but i put it on B and it rolled up to A.

4

---

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can Rolld from A.to B. but it didn't go from B t, A. The funnels Rolld from B.to A but not from A to B.

4

---

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

4

The can went fast on a and B. The funnel stad on a and did not roll. The funnel on B went backwords.

Part 5

SEVENTH GRADE SCORE POINT 4

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

the can rolled forwards
fast at both points the
funnel didn't roll at all at point
A put rolled up the ramp
backwards quickly.

4

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolled forward off the wood
block it rolled faster from point A and
slower at B the funnels didnot roll at all
when it was on A, but when it was on B it
rolled backwards

4.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

THE Funnels stayed there at point A
and at point B rolled up to point A
THE Can rolledof the end at point A
towards point. B. And at point B it
just rolld off

4.

ELEVENTH GRADE SCORE POINT 4

Part 5

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolls normally (forward) at points A and B. The funnels sort of roll one side, then the other; first forward towards B, then backwards back towards A. When it is put at point B, it only rolls backwards to A

ALSO - it needs to be pushed to get rolling

4

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolls from A to B, the funnels roll from B to A. The funnels stop at A, but the can does not stop at B. When the can is placed at B it rolls off the edge. when the funnels are placed at A the do not roll.

4

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

- the can always moves from point A to point B, never from B to A
- the funnel doesn't move from A to B but will move from B to A

4

Part 5

THIRD GRADE SCORE POINT 3

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY. 3

The funnels rolled from b to a. the can rolled from a to b.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY. 3

The can only roled from A to B. The funnels only roled from B to A.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

When I put the two Funnels at point be x went but y didn't when I put y at b it went and when I put x at b it went to. 3

Part 5

SEVENTH GRADE SCORE POINT 3

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The funnel rolled up to "A" and the can rolled off. 3.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolls down from "A" to "B" because the top of the piece of wood is downhill. 3.

The funnel rolls from "B" to "A" because at "B", the funnell doesn't have room to sit between the pieces of wood all the way so it goes to "A" where the spaces between the wood are wide enough for it to sit down all the way. So as the pieces get wider, it has more room so for the funnel it is like going downhill.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can went from point A to B and the funnels went from point B to A. 3.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolled to the lower place because of gravity. Although the funnel went up, it's center of mass went down because of the ways it fit on the track. the can went from A to B and kept going. The funnel went from B to A and stopped at A because it hit the wood. Thetrack is wider of A so that the funnel could get lower.

3

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolled to the left of pt. A and when it rolled from pt. A its speed was faster than at pt B. The funnel on the other hand rolled to the right of pt. B and stopped at pt. A. When it was placed at pt A it made no motion.

3

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolled From Point A to point B and from Print B to the table. However the funnel rolled from point B to point A. The can is so large that it didn't get caught between the pieces of wood and it just rolled down the incline. However the funnel rolled "up" because it was being propelled by being caught between the pieces of wood that was hitting against the curvature on the actual funnel. The funnel starts between the close end of the pieces of wood and goes "up" as the wood gets further apart.

3

Part 5

THIRD GRADE SCORE POINT 2

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY. 2

The can went down
The funnel down & up

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY. 2

The can rolled faster but
it did not come back.
The fenner came back.

WHAT DID YOU FIND.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY. 2

X will not go up o but
Y will

Part 5

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

for the can the force of gravity pulled it down at point A. for the funnels, as the wood opened the funnels went down it.

2

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolled down and the funnel staid and then rolled down.

2

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The funnels rolled backward because of the shape of the 2 stuck toghether

2

Part 5

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can Rolled in the direction from A to B and beyond because the center of gravity of the can always Remained in equal distance fro the wood. However, the [illegible]unnel's center of gravity became lower [illegible] it moved towards A.

2

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

~~At~~. A the can rolled slowly and the same happened at pt. B. At pt A the 2 connected funnel didn't roll; at pt. B they didn't roll either. The center was too big for the opening on the incline plane. The can rolled freely; the 2 funnels that are connected didn't roll.

2

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

Because of the shape of the funnels, they must reach a point between the 2 pieces of wood that are as wide or wider in order to be still. The can on the other hand will roll from A to B because its surface is not uneven and B is lower than A. The can has no choice but to roll toward the gravitational pull at point B. If the 2 pieces of wood were the same distance from each other at both points, the funnel would roll toward B when put on A. This is because point B is lower than point A.

2

Part 5

THIRD GRADE SCORE POINT 1

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

- The can moved slowly. And the funnels moved faster.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

the caN gos faster then the fuNNels

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

it rolled tords a

ELEVENTH GRADE SCORE POINT 1

Part 5

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can did not roll at all. It took the funnel Two seconds. 1.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The fonnal ~~bit~~ had two long edges ~~a~~ to cup it on the board and the can was too wide so it could not get to point B 1.

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

1st of all the can rolled and the funnel didn't 1.

Part 5

5) WRITE DOWN THE WAYS THAT THE CAN AND THE FUNNELS ROLLED DIFFERENTLY.

The can rolled the same way from points A & B, it rolled straight down. The Funnels veered off to the side so they fell off the wood when rolled from point A but rolled straight from point B because they didn't have time to veer to the side.

①

Comments on Rolling Funnels (Grades 3, 7, and 11)

This activity required students to make observations and report their findings. NAEP's advisory panel liked the apparatus including the double cone of funnels rolling uphill, but felt the questions should be reformulated to assess how students deal with a counterintuitive situation. They felt that the innovative apparatus was in a sense wasted by having this activity be observational only. Thus, it was suggested that after the students roll the can, they be asked to predict how the funnel will roll. After rolling the funnel, they might be asked if they were surprised and what they might want to do next to see why the funnel rolled up hill.

The discussion for Rolling Funnels was parallel to that for Sand and Tubes regarding administration procedures. The consultants had the same reservations about students erasing their predictions after the fact and suggested that opportunities for them to do this should be avoided. This activity might be group administered or done by computer simulation. A group administration would be more cost effective, while the computer simulation would provide a way to record student predictions.

In summary, the questions should be revised to use the apparatus in a way that capitalizes on it's appropriateness for making predictions. The mode of administration could be changed to group, computer simulation, or computer with videodisc.

STATION 5

HOW DOES THE WIG-WAG MOVE WITH THE DIFFERENT BLOCKS IN THE TRAY?

THIS IS A WIG-WAG. PUSH THE END OF THE TRAY SIDEWAYS A BIT AND THEN LET GO. DO YOU SEE WHAT HAPPENS? THIS IS THE REASON WE CALL IT A WIG-WAG.

HERE'S WHAT YOU DO:

1) LOOK AT THE BLOCKS LABELLED A, B, C, AND D.

2) LIFT EACH BLOCK ONE AT A TIME. WHAT DO YOU NOTICE ABOUT THE BLOCKS?

3) PUT ONE OF THE FOUR BLOCKS IN THE TRAY AND MOVE THE WIG-WAG. NOTICE HOW THE WIG-WAG MOVES. NOW TRY WITH THE OTHER BLOCKS.

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

Activity Identification: Wig-Wag

Grade(s): 3,7

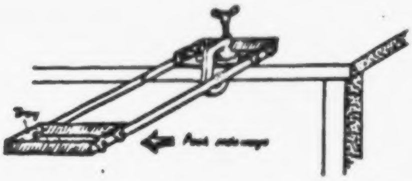
Method of Administration: Self-Administered Station Activity

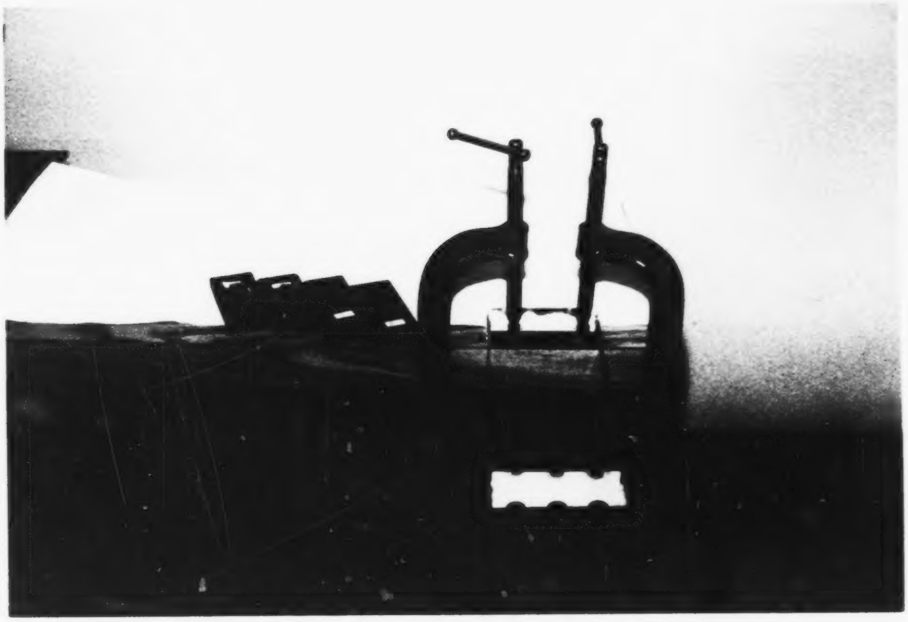
Content Area: Science-Physics

Apparatus required: One inertia balance, two large C-clamps, one block of lead labelled A, one block of aluminum labelled B, one block of wood labelled C, one block of balsa wood labelled D, pan scale, timer, and graph paper. (Picture below only shows one clamp.)

Administration: The Wig-Wag should be set up using 2 G-clamps in opposite corners as shown in the diagram on the inside of the box. The blocks should be placed in a standardized, sequential order next to the Wig-Wag.

Servicing: None required





Wig-Wag
Station B
Grade 3 - station 5
7 - station 4

Scoring of the Written Responses

4) Score 3 points if the student accurately notes the relationship between the weight of the block and the rate of movement of the Wig-Wag (i.e, the heavier the block, the slower it moves). The student may express this relationship in a statement, a series of statements, or graphically (note should be taken if the relationship is expressed graphically). Score 2 points if the student only notes that the Wig-Wag moves differently with different blocks in the tray. Score 1 point if the student makes an irrelevant response. Score 0 if the student makes no response.

Skills involved

In this exercise students are asked to hypothesize the relationship between weight and rate of movement. This relationship can be deduced by comparing and contrasting how changes in the independent variable (i.e., the weight of the block) bring about changes in the dependent variable (i.e., rate of movement of the Wig-Wag).

Part 4

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

when the hevyer block are in the wig wag it moves slower than when the lighter ones are in it

3'

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

when the block is heavy it moves stow. and when it is light it moves fast

3'

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

The wag wag when the lite blocks are put in it goes fast but when the heavy blocks are put in it goes slow

3.

Part 4

SEVENTH GRADE SCORE POINT 3

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

The lightar the block is the more it moves.

3.

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

The heavier the slower it moves

3.

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

the heavier the block, the longer it takes to go back and forth.

3.

THIRD GRADE SCORE POINT 2 Part 4

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

The biggest on moved alittle
The smallost movedalot And the
Second biggest movedalittle
Same withe Second littleone

2

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

A moves a little fast. B moves
fact. c makes a cliking sound.
d moves very slow.

2

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

A. moves fast D moved slowly.
B moves faster
C moves faster

2

SEVENTH GRADE SCORE POINT 2 Part 4

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

For block A it goes very slow block B slow block C fast block D very fast.

2

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

A is heavier and moves slower B is alittle liteter C is lite and it moves fast D has hardly no weight and it ~~S~~ flies away becauce. of no trivcal force.

2

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

The D block was so light it fell out. The C black stayed in but allowed the wig-wag to move rapidly The wig-wag moved slowly with the B block. The wig-wag was jittering and didn't move much at all with the A block

2

THIRD GRADE SCORE POINT 1

Part 4

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

They all take long to stop.

1.

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

the wig wag moves side to side as it goes some blocks are heavier Some are lighte

1.

EXPLAIN WHAT YOU FOUND:

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

I think it is the weight

1.

Part 4

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

A it moves slow but fast

B is

1

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

The wig - wag moves at the same speed with all blocks but it bends with the heavier block and stays straight with the lightest block.

1

4) DESCRIBE THE RELATIONSHIP BETWEEN THE WEIGHT OF THE BLOCKS AND HOW THE WIG-WAG MOVES.

the lighter the weight, the less it moves. With the heaviest, it moved the most

1

Comments on Wig-Wag (Grades 3 and 7)

This activity required students to determine the relationship between the weight of a block and how the Wig-Wag apparatus moved. They were asked to make observations and infer the relationship. Despite the fact that the apparatus for this task weighs about 10 pounds, the activity was well received by the panel members and appears appropriate for third and seventh graders. The results indicate that third grade students understood the task, in that about three-fourths answered at the minimal level or above. Almost two-thirds of the seventh graders were able to observe and accurately note the relationship between the weight of the block and the rate of movement of the Wig-Wag.

The panel suggested that amplitude is also an important aspect of this activity and that the lighter the block the faster and further the Wig-Wag should move. This should be kept in mind when refining the scoring guide.

The panel also suggested that it might help third graders to write down their observations after trying the first block. Thus, part three might read as follows:

3) Put one of the four blocks in the tray and move the Wig-Wag. Notice how the Wig-Wag moves. Write down what you saw.

____

____

____

____

The remaining steps in the task would remain the same, but be renumbered accordingly. In summary, this task is recommended for use in future assessments either as pilot tested or with slight modification.

STATION 1

YOU ARE GOING TO PLAY THE CIRCLE GAME WITH THE COMPUTER. THE COMPUTER WILL TELL YOU WHAT TO DO AND YOU WILL PUT ALL YOUR ANSWERS INTO THE COMPUTER.

NOW, TURN THE COMPUTER ON.

Activity Identification: The Circle Game

Grade(s): 3

Method of Administration: Self-Administered Station Activity/Computer

Content Area: Mathematics-Numerical Reasoning

Apparatus required: Apple II Series Computer with 48k memory, diskette with program, paper and pencil.

Administration: Administrator should type in the student's code at the onset of each administration and reset the program at the end of each administration.

Servicing: None required

Remember

Press the *RETURN* key after you enter a number or answer a question.

Self-Administered Station Activity- 3

Circle Game

Note: The computer will display a row of 13 circles.

Who gets the last circle?
The last circle loses.

How many circles do you want (1 or 2)?
Press the number on the keyboard.

Note: The computer will cross out the number of circles that the student chooses with vertical hatch marks.

The computer takes (some number) circles.

Note: Circles chosen by the computer will be crossed out with horizontal hatch marks.

Do you see how to play?
Press Y for yes. Press N for No.

Note: If student presses Y, the game will proceed. If student presses N the program will display the following prompt and start the program from the beginning.

Okay, let's go over it again.

Note: If the student presses Y the program will display the following prompt.

Do you want to go first or should the computer go first.
Press M for yourself.
Press C for the computer.

(After the student has made a response) **How many circles (1 or 2)?**

The computer takes (some number) circles.

Note: After each game the computer will display one of the following. **Hooray, you win!** (if the student wins) or **Sorry, maybe you'll win another time!** (if the computer wins).

The computer will then display.
You're a good person to play against. Let's play again.

Note: The program will then proceed as it did in the first game for 4 more games.

Probe questions to follow the game- 3

Is there a way that you can play so that you can be sure of winning?
Press Y for yes. Press N for no.

Does it make a difference in your chance of winning whether you start or the computer starts?
Press Y for yes. Press N for no.

If you pressed Y, who would you want to go first? Press M for yourself. Press C for the computer.

(If the student pressed N, program should go to the next question)

If there were three circles left and it was your turn, how many would you need to cross out to be sure to win?

Press 1 for one circle. Press 2 for two circles. Press N if you do not think that you could be sure to win if there were three circles left.

If there were four circles left and it was your turn, how many would you need to cross out to be sure to win?

Press 1 for one circle. Press 2 for two circles. Press N if you do not think that you could be sure to win if there were four circles left.

Thank you. It's been fun.

The Circle Game
Station B
Grade 3 - station 1

Only responses to questions will be scored, but a tally and notes will be kept on evidence of developing strategies and inconsistencies in sampling behavior.

1) **Is there a way you can play so that you can be sure of winning?**
   Score 2 pts. for **Y** (yes).
   Score 1 pt. for **N** (no).
   Score 0 for no response.
2) **Does it make a difference in your chance of winning whether you start or the computer starts? If you pressed Y, who would want to go first?**
   Score 3 pts. for **Y** followed by **C** (computer).
   Score 2 pts. for **Y** followed by **M** (myself).
   Score 1 pt. for **N** (no).
   Score 0 for no response.
3) **If there were 3 circles left and it was your turn, how many would you need to cross out to be sure to win?**
   Score 3 pts. for **2**.
   Score 2 pts. for **1**.
   Score 1 pt. for **N** (You can't be sure to win).
   Score 0 for no response.
4) **If there were four circles left and it was your turn, how many would you need to cross out to be sure to win?**
   Score 3 pts. for **N** (You can't be sure to win).
   Score 2 pts. for **2**.
   Score 1 pt. for **1**.
   Score 0 for no response.

Skills involved:

In this exercise students need to formulate hypotheses and develop a strategy to solve a mathematical problem.

Comments on the Circle Game (Grade 3)

This is a computer-administered game of strategy requiring numerical reasoning. In the game the computer displays 13 circles. The student and computer take turns crossing out one or two circles until the player forced to cross out the thirteenth one loses. After a practice game, the student plays four games. In each game, the student chooses whether to go first or have the computer begin. Finally the student is asked four questions which try to probe the student's understanding of what is needed to win and whether the student has developed a winning strategy.

Because there is a strategy by which a player can always win when the other player starts, the computer has been programmed to use this strategy and to win whenever the student elects to go first. When the computer is told to start, it has been programmed to cross out one or two circles randomly so that, depending on the student's strategy, the computer may win or lose.

Unfortunately, almost half the data was lost when, for some unclear reason, most of the student responses were not recorded on the disk while the students were playing.

Based on review of the limited records on the disks, it seems that the student understood how to play. Although there was little evidence that these students recognized a winning strategy, about 20 percent played at least one "perfect" game (i.e., the student used the same strategy when the computer started as the computer was programmed to use when the student started). According to the administrators, the students enjoyed the task, although they reported that the 8 minutes allowed was too little time. The reports of insufficient time were supported by the limited data obtained. A longer time, probably 10 minutes, is suggested.

The program also needs revision. Some suggestions for revisions are to tell students at the beginning that there will be questions to answer after the game; to reverse the order of questions, asking the strategy questions after the specific ones about who would win; and to provide a continuous display of the goal of the game on the screen.

In summary, the task appears appropriate for third grade. However, NAEP needs to revise the program, determine appropriate time requirements, and develop a better understanding of the operational constraints of computer administrations. This task requires further pilot testing.

STATION 1

YOU ARE GOING TO PLAY THE NUMBER GAME WITH THE COMPUTER. THE COMPUTER WILL TELL YOU WHAT TO DO AND YOU WILL PUT ALL YOUR ANSWERS INTO THE COMPUTER.

Activity Identification: The Numbers Game

Grade(s): 7,11

Method of Administration: Self-Administered Station Activity/Computer

Content-Area: Mathematics-Numerical Reasoning

Apparatus required: Apple II Series Computer with 48k memory, diskette with program, paper and pencil

Administration: Administrator should type in the student's code at the onset of each administration and reset the program at the end of each administration.

Servicing: None required

2
Remember
Press the RETURN key after you
enter a number or answer a question.

Self-Administered Station Activity- 7,11

You are about to play the Numbers Game. You will be playing against the computer. You will play one practice game to get you acquainted with the object and rules of the game. Then you will play a few games for real against the computer.

The Numbers Game begins with the number 0. Each player then gets a turn to add 1 or 2 to that number. The object of the game is to force the other player to reach or exceed unlucky 13.

(Practice game 1) **Okay, let's try a practice game. Do you want to go first or should the computer start? Press M for yourself. Press C for the computer.**

(For the student's turn)
Add either 1 or 2 to this number by pressing 1 or 2 on the keyboard.

(For the computer's turn)
The computer adds (1 or 2).

Note: After the game has been completed the computer will display: **Hooray, you win!** (if the student wins) or **Sorry, maybe you'll win another time!** (if the computer wins).

Now you are ready to play the real game. Do you want to go first or should the computer go first? Press M for yourself. Press C for the computer.

Note: Program will proceed with the prompt asking the student to make a move (if the student pressed M) or with the prompt telling the student which number the computer wants to add (if the student pressed C) as in the practice game.

Probe questions to follow the game-7,11

If you start, can you play so that you always will win?
Press Y for yes. Press N for no.

If the computer starts, can you play so that you will always win?
Press Y for yes. Press N for no.

If the computer says 11, who will win?
Press M for yourself. Press C for computer.
Suppose the game is played so that each player can add 1, 2 or 3 at each turn. What is the highest number below 12 you can reach and be sure of winning?

Press this number on the keyboard.

Thank you. It's been fun.

Comments on the Numbers Game (Grades 7 and 11)

This exercise is a computer-administered numerical reasoning game based on the mathematical game NIM and similar to the Circle Game for grade 3. At grades 7 and 11, the game is explained in words on the computer screen and students play without the visual aid of the circles being crossed out. The questions after the games are also different.

In administration, there were the same problems of unrecorded data with this task as with the Circle Game. Only 42 cases survived at grade 7 and 61 cases at grade 11. Among the students for whom there was data, only 30 percent of grade 11 students completed the task while 55 percent of the grade 7 students did. In grade 11, 5 students seemed to recognize the game, using the same winning strategy throughout.

The advisory panel who reviewed the program and the data liked the task and the inclusion of computer-administered exercises. However, as for all the computer-administered exercises, revisions of the program are necessary and new pilot testing of the revised program would be needed before any operational use. Also, students should be given more time to complete the exercise.

STATION 6

WHAT HAPPENS WHEN YOU PUT WATER ON THESE THINGS?

HERE'S WHAT YOU DO:

1) PLACE A DROP OF WATER ON EACH MATERIAL.

2) LOOK CAREFULLY. WHAT DO YOU SEE?
WRITE DOWN WHAT HAPPENS TO THE WATER ON EACH OF THE MATERIALS.

A) PLASTIC ______________________________

B) PAINTED WOOD ______________________________

C) BRICK ______________________________

D) METAL ______________________________

E) ROOF SHINGLE ______________________________

F) GLASS ______________________________

3) NOW USE YOUR MAGNIFYING GLASS AND LOOK AT EACH MATERIAL VERY CLOSELY.

4) LOOK AT THE MATERIAL IN THE PLASTIC BAG VERY CLOSELY.
DO NOT OPEN THE BAG.

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG.

____

____

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN.

____

____

Activity Identification: Water on Brick

Grade(s): 3

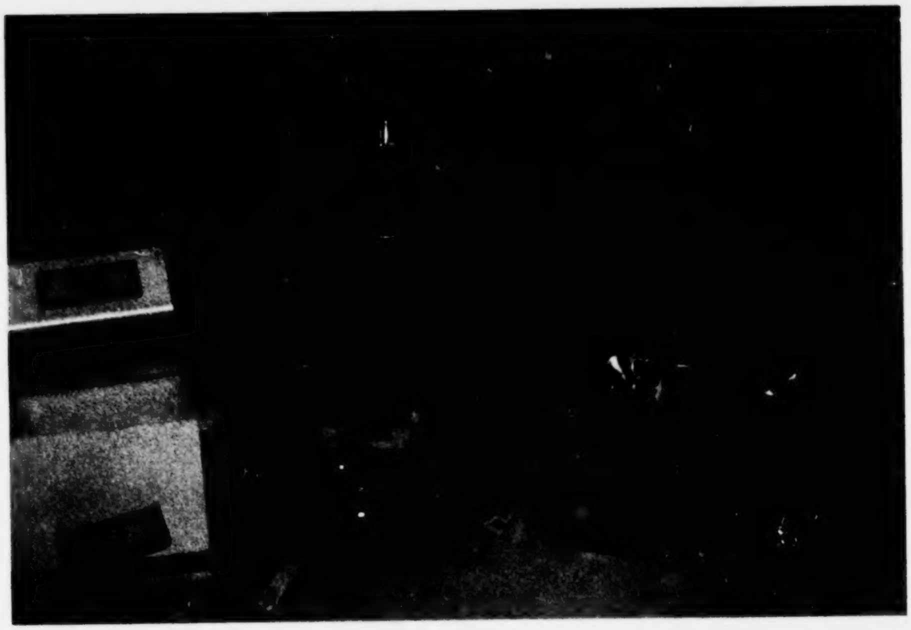
Method of Administration: Self-Administered Station Activity

Content Area: Science-Physical science

Apparatus required: Eyedropper, small bottle filled with water; small equal-sized pieces of plastic, painted wood, brick, metal, roof shingle, and an unknown material (piece of porous cinder block) in a transparent, plastic bag; magnifying glass, paper and pencil.

Administration: The Administrator should keep the level of the water in the dropping bottle filled for each administration. Excess water should be wiped off all the surfaces after each administration for each child. The brick and roof tile should be replaced after every other administration if possible. All materials should be turned over after they have wiped off before each administration.

Servicing: None required



Water on the Brick
Station A
Grade 3 - station 6

Scoring of the Written Responses

2) Score 1 pt. for each accurate (or seemingly plausible) observation starting with code pt. 2 of how the waters act on each of the materials.

   a) Plastic - runs off or remains
   b) Wood - drop remains
   c) Brick - drop soaks in
   d) Metal - drop remains
   e) Roof shingle - drop soaks in
   f) Glass - drop remains (spreads)

   Score 1 pt. for a set of irrelevant responses (i.e. "yes", "no").

   Score 0 if the student makes no response.

5) Score 2 pts. if the student provides a reasonable hypothesis about how the water will act on the unknown material; i.e. **It will soak in; It will be absorbed.** Score 1 pt. if the student provides an erroneous hypothesis about how the water will act on the unknown material. Score 0 if the student makes no response.

6) Score 2 pts. if the student is able to provide a plausible reason or set of reasons why the water will act a certain way on the unknown material; i.e. **It will act like the brick because it looks like it's made of the same material.** Score 1 pt. if the student responds but does not provide a plausible reason why the water will act a certain way on the unknown material. Score 0 if the student makes no response.

Skills involved

In this exercise the student needs to generalize inferences about a "known" set of entities to an "unknown." The basis for this generalization are the comparisons and contrasts made among the "known" stimuli.

Part 2

THIRD GRADE SCORE POINT 1

1) PLACE A DROP OF WATER ON EACH MATERIAL.

2) LOOK CAREFULLY. WHAT DO YOU SEE?
WRITE DOWN WHAT HAPPENS TO THE WATER ON EACH OF THE MATERIALS.

A) PLASTIC It gets darker.
B) PAINTED WOOD I gets darker.
C) BRICK It get cleanee. ①
D) METAL It get Brighter.
E) ROOF SHINGLE It gets cleaner.
F) GLASS you can Bearly seeit.

THIRD GRADE SCORE POINT 5

1) PLACE A DROP OF WATER ON EACH MATERIAL.

2) LOOK CAREFULLY. WHAT DO YOU SEE?
WRITE DOWN WHAT HAPPENS TO THE WATER ON EACH OF THE MATERIALS.

A) PLASTIC nuthing ✓
B) PAINTED WOOD nuthing ✓
C) BRICK soks ✓ ⑤
D) METAL it gets the metal wet ✓
E) ROOF SHINGLE soks in ✓
F) GLASS disupairs

THIRD GRADE SCORE POINT 7

1) PLACE A DROP OF WATER ON EACH MAT

2) LOOK CAREFULLY. WHAT DO YOU SEE?
WRITE DOWN WHAT HAPPENS TO THE WATER ON EACH OF THE MATERIALS.

A) PLASTIC nothing happens. ✓ ⑦
B) PAINTED WOOD nothing happens
C) BRICK It fades so you can't see it. ✓
D) METAL The drop becomes a circle ✓
E) ROOF SHINGLE It fades so you can't see it.
F) GLASS It stays the same. ✓

Part 5

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG.

it would soak throuh

②

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG.

I think it would disapear.

②

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG.

it would sink in
to it

②

Part 5

THIRD GRADE SCORE POINT 1

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG.

it would evapertate. ①

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG.

it gets bigger ①

5) WRITE DOWN WHAT YOU THINK WOULD HAPPEN IF YOU PUT A DROP OF WATER ON THE MATERIAL IN THE BAG. ①

It will get cleaner.

THIRD GRADE SCORE POINT 2 Part 6

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN. ②

because water finds holes to seep in or seep out of an object.

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN.

Beause It soaked throuh the Brick, and Roof shingle, and it is made of the same Specimens, ②

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN.

because it is the same material as the brick. ②

Part 6

THIRD GRADE SCORE POINT 1

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN. ①

Water cleans things.

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN. ①

it is hot so it evaperates.

EXPLAIN:

6) WRITE DOWN WHY YOU THINK THIS WILL HAPPEN. ①

I think this would happen
because the bag is closed

Comments on Water on Brick (Grade 3)

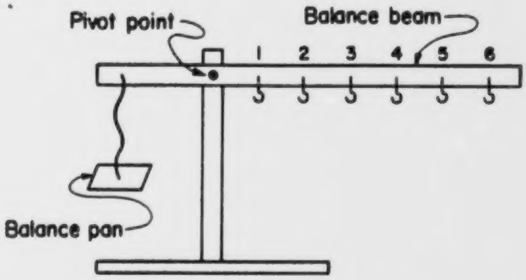
Part 2 of this exercise, which calls for careful observation and reporting of what happens to a drop of water on different materials, appears to be appropriate for grade 3 students. The 33 percent who reported accurately on all six substances may be an underestimate because some of the roof tiles (shingles) provided to the project in the sets of materials had not been thoroughly cleaned which may have affected what happened to the water when it was dropped on the tile.

Unfortunately, the unknown material in the bag was most like the roof tile. Because we do not know how many children had the poor roof tile specimens or how many dropped water on them in the area where it would not soak in, there is no way to tell to what extent the 31 percent who answered part 5 correctly also is an underestimate. In spite of this, the data indicates that the percent of students who observed and formed an accurate hypothesis about what would happen with the material in the bag was greater than the 18 percent who gave a plausible reason for what would happen.

In spite of the roof tile problem, the project staff and the advisory panel concluded that this task could be used in a future assessment without any change, except to ensure the usage of new roof tiles. Also, because this task was based on one used in the APU science assessment at age 13, it was decided that this task also could be used for grade 7 without pilot testing.

STATION 6

HOW CAN YOU BALANCE THE BALANCE BEAM?



HERE'S WHAT YOU DO:

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER?

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

Activity Identification: Balance Scale

Grade(s): 7, 11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Physics

Apparatus required: A balance scale set up and balanced with equally spaced holes for hooks as shown in the diagram below, five 10 gram metal washers, one 30 gram plastic canister; paper and pencil.

Administration: Weights should be placed next to the balance scale before the onset of each administration.

Servicing: None required

Balance Scale
Station B
Grade 7 - station 6
11 - station 6

Scoring of the Written Responses

1) Score 2 pts. if the student provides the correct answer 3. Score 1 pt. if the student makes an incorrect response. Score 0 if the student makes no response or indicates that she or he doesn't know the answer.

(grade 7)
2) Score 2 pts. if the student states that the mass of the plastic cylinder is 30g. Score 1 pt. if the student makes an incorrect response. Score 0 if the student makes no response.

(grade 11)
2) Score 2 pts. if the student states that the mass of the plastic cylinder = 3 washers. Score 1 pt. if the student makes an incorrect response. Score 0 if the student makes no response.

3) Score 2 pts. if the student provides a response that would balance the scale. Acceptable responses include the following: 3 on peg 3; 1 on peg 1, 1 on peg 2, 2 on peg 3; 1 each on pegs 1,3, and 5; 1 each on pegs 2, 3, 4; 1 on peg 3, 1 on peg 6; 1 on peg 4, 1 on peg 5; 1 on peg 1, 1 on peg 2, 1 on peg 6.

Score 1 pt. if the student provides an irrelevant or incorrect response. Score 0 if the student makes no response or indicates that she or he doesn't know the answer.

Note to scorers: Any instances where the student has balanced the scale correctly in 3) but misinterpreted the implications in 2 should be recorded. Students' responses to 3 also should be recorded.

Skills involved

In this exercise students need to determine the relationship between two variables. This determination needs to be made by simultaneous manipulation of variables and also by holding one of the variables constant.

Part 1

SEVENTH GRADE SCORE POINT 2

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL? ②

yes you must hang a washer. you must hang on the third one in brom the pivet

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

The third hook ②

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

third From left ②

Part 1

ELEVENTH GRADE SCORE POINT 2

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

#3 ②

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL? ②

3rd

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL? ②

the 3rd hook

Part 1

SEVENTH GRADE SCORE POINT 1

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

0 ______ 1

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

put it right next to it ______ 1

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

the 4th one ______ 1

Part 1

ELEVENTH GRADE SCORE POINT 1

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

nowhere, the beam was already level. ①

1) PLACE ONE WASHER ON THE BALANCE PAN. ON WHICH HOOK, COUNTING TO THE RIGHT FROM THE PIVOT POINT, MUST YOU HANG ONE WASHER TO MAKE THE BALANCE BEAM LEVEL?

The 4th hook ①

Part 2

Seventh Grade Score Point 2

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER? ②

30 grams

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER?

The plastic cylinder is 30 grams ②

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER?

30 grams ②

Part 2

ELEVENTH GRADE SCORE POINT 2

2) Now REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. USING THE WASHER AS YOUR UNIT OF MASS, THE MASS OF THE PLASTIC CYLINDER IS HOW MANY WASHERS?

3 washers ②

2) Now REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. USING THE WASHER AS YOUR UNIT OF MASS, THE MASS OF THE PLASTIC CYLINDER IS HOW MANY WASHERS?

[illegible] 3 washers ②

2) Now REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. USING THE WASHER AS YOUR UNIT OF MASS, THE MASS OF THE PLASTIC CYLINDER IS HOW MANY WASHERS?

3 washers ②

Part 2

SEVENTH GRADE SCORE POINT 1

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER?

40 grams

1

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER?

40 grams

1

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. IF THE MASS OF EACH WASHER IS 10 GRAMS, WHAT IS THE MASS OF THE PLASTIC CYLINDER?

40 grams

1

Part 2

ELEVENTH GRADE SCORE POINT 1

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. USING THE WASHER AS YOUR UNIT OF MASS, THE MASS OF THE PLASTIC CYLINDER IS HOW MANY WASHERS?

2 washers

①

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. USING THE WASHER AS YOUR UNIT OF MASS, THE MASS OF THE PLASTIC CYLINDER IS HOW MANY WASHERS?

3 1/3

①

2) NOW REMOVE THE WASHER FROM THE BALANCE PAN AND PUT THE PLASTIC CYLINDER ON THE PAN. USING THE WASHER AS YOUR UNIT OF MASS, THE MASS OF THE PLASTIC CYLINDER IS HOW MANY WASHERS? 3½ washers

[illegible]

①

Part 3

SEVENTH GRADE SCORE POINT 2

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

Three washers on the third hook (2)

5) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

2 washers 5th hook (2)

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

7 on the 7 3 6 ([illegible])

Part 3

ELEVENTH GRADE SCORE POINT 2

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

I used 3 washers and hung all three on the 3rd hook

②

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

2 - one on #3 and 1 on #6

or 3 - 3 on #3

②

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

2 washers: hooks 4+5

it also works with 4 washers

on hooks 1-4

and 2 on 3+6

②

Part 3

SEVENTH GRADE SCORE POINT 1

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

the first four. ①

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

3 ①

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

hooks 2 and 3 (2) washers ①

Part 3

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

3: 1, 3, 6 ①

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM? ①

I used 3 washers, placing them on the 1st, 3rd, and 6th hooks

3) HOW MANY WASHERS DID YOU USE AND ON WHICH HOOK(S) DID YOU HANG THEM?

I used 3 washers on the 4th hook. ①

Comments on Balance Scale (Grades 7 and 11)

In this exercise, the balancing required to answer the questions can be done by trial and error. However, the solution to Part 2 requires some interpretation of what the balancing results imply about the mass of the plastic canister. Part 3 was included to gather information about the various ways in which the students obtained the balance and to find out how many were able to balance the scale but misinterpreted the result when determining the mass of the canister.

One problem with this exercise is that there is no way of knowing whether the students who used hooks 2, 3, and 4 or any other combination of 3 washers that worked, such as 1, 3, and 5 or 1, 2, and 6, understood how to interpret this or simply answered 30 grams because they used three 10-gram washers. Those students who used only two washers for balancing clearly knew what they were doing if they gave the correct mass, but the 2-washer solutions were more prone to misinterpretation. If this task is to be used in the future, students should be asked to explain how the configuration of washers they used led to the mass they reported.

In conclusion, this exercise should not be used in a future assessment as it was pilot tested even though the panel did like the idea. If the idea is to be used as the basis for an exercise, the design of the balance scale must be improved to make it less fragile. Also, the exercise must be revised to avoid the present possibility of arriving at a correct result with erroneous thinking. Any revised exercise would need some new pilot testing.

STATION 5

HOW MANY BLOCKS ARE IN THE STAIRCASE?

HERE'S WHAT YOU DO:

1) LOOK AT THE "STAIRCASE" OF BLOCKS.

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE?

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

Activity Identification: Double Staircase

Grade(s): 3,7,11

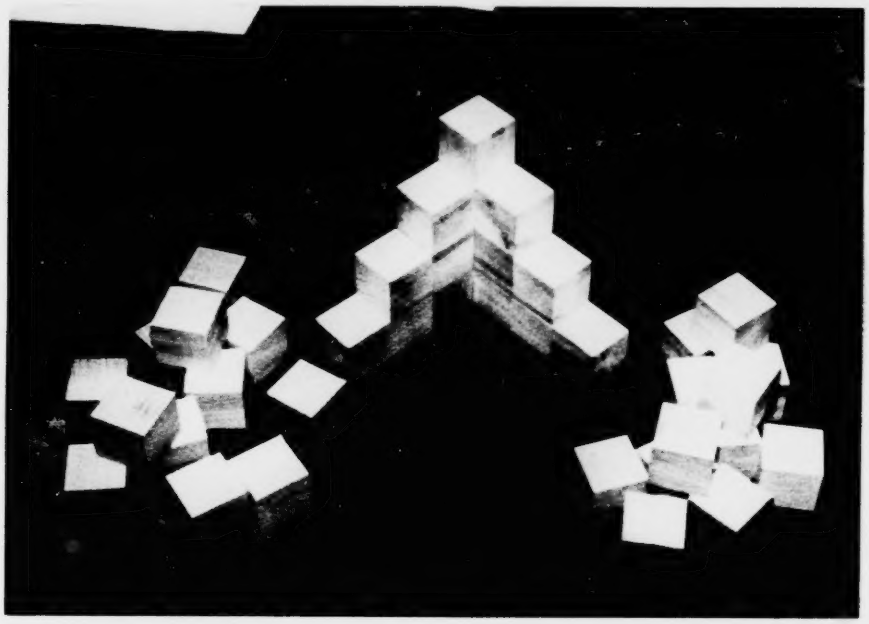
Method of Administration: Self-Administered Station Activity

Content Area: Mathematics-Algebra

Apparatus required: "Double staircase" of wooden blocks that is 4 blocks high, and glued to a wooden base; 24 loose wooden blocks that are identical to those used in the staircase; graph paper and pencil.

Administration: Loose blocks should be placed alongside the staircase after every administration.

Servicing: Potential re-gluing of blocks onto staircase if they should become loosened or dislodged from the base.



Double Staircase
Station A
Grade 3 - station 5
7 - station 5
11 - station 5

Scoring of the Written Responses

2) Score 3 pts. if the student accurately determines the number of blocks in the staircase to be 16. Score 2 pts. if the student makes an incorrect answer of 13. Score 1 pt. if the student makes any other incorrect response. Score 0 if the student makes no response.

3-4) Score 3 pts. for each question if the student provides the correct answer and shows work which is consistent with these answers. For question 3 this answer is 36 and for question 4 this answer is 100. Accurate written responses may substitute for the show of work. Score 2 pts. for each question if the student provides the correct answer or appropriate work but not both. Score 1 pt. each for questions 3 and 4 if the student provides an incorrect response. Score 0 if the student makes no response.

5) Score 2 pts. if the student accurately determines the relationship between the height of the staircase and number of blocks needed to build it. This relationship may be expressed in a written statement or algebraically (note should be made of how the relationship is specified). Scoreable responses would include the following: n^2 or n x n for a staircase n blocks high; h^2 or h x h; n= h x h; $n=h^2$; The number of blocks needed to build a staircase is the square of the height of the staircase or is the height of the staircase times itself. Any other equivalent algebraic expressions algebraically or equivalent statements also may be accepted as scoreable responses. Score 1 pt. if the student provides a response but is unable to specify the relationship. Score 0 if the student provides no response.

Skills involved

In this exercise the student needs to determine the nature of a mathematical relationship. This relationship can be deduced by making generalizations based on the student's findings.

Part 2

THIRD GRADE SCORE POINT 1

1) LOOK AT THE "STAIRCASE" OF BLOCKS.

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 17

(1)

THIRD GRADE SCORE POINT 2

1) LOOK AT THE "STAIRCASE" OF BLOCKS.

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 10

(2)

THIRD GRADE SCORE POINT 3

1) LOOK AT THE "STAIRCASE" OF BLOCKS.

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 16

(3)

SEVENTH GRADE SCORE POINT 1 Part 2

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 21 (1)

SEVENTH GRADE SCORE POINT 2

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 13 (2).

SEVENTH GRADE SCORE POINT 3

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 16 (3)

ELEVENTH GRADE SCORE POINT 1

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 10 (1)

ELEVENTH GRADE SCORE POINT 2

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 13 (2)

ELEVENTH GRADE SCORE POINT 3

2) THE STAIRCASE IS 4 BLOCKS HIGH. HOW MANY BLOCKS ARE IN THE STAIRCASE? 16 blocks (3)

Part 3

THIRD GRADE SCORE POINT 3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

I added blocks and counted. 36 ③

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH? 36
HOW DID YOU FIGURE OUT YOUR ANSWER?

by useing the blocks ③
of [illegible] and adding

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

3[illegible] I counted them. [illegible]

Part 3

SEVENTH GRADE SCORE POINT 3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

36 I hypothesized it was 8^2, then build to prove.

3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

36 blocks I figured it out by adding [illegible] [illegible] and counting how many [illegible] [illegible]

3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

[illegible]

[illegible]

Part 3

ELEVENTH GRADE SCORE POINT 3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

36 [illegible] squared 8 ③

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

36 One side of the case is ½ of a square w/ 8 blocks on each side ③

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 8 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

36 I built half a staircase and multiplied by 2. ③

Part 3

THIRD GRADE SCORE POINT 2

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 5 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

I made one ②
and it ed

4) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

21 ③

Part 3

SEVENTH GRADE SCORE POINT 2

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

36 blocks ②

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

36 ②

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER? 36

②

Part 3

ELEVENTH GRADE SCORE POINT 2

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER? 3 6 ②

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER? 36 ②

Part 3

THIRD GRADE SCORE POINT 1

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH? 48
HOW DID YOU FIGURE OUT YOUR ANSWER?

I built another staircase 6 blocks high.

1

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH? 38
HOW DID YOU FIGURE OUT YOUR ANSWER?

I added

①

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?

You add 4 six times.

①

Part 3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH? 32
HOW DID YOU FIGURE OUT YOUR ANSWER?
you just ad on 4 then 5
blocks.
①

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?
21, I put 6 in one row, 5 in the next, the 4,
then 3, then 2, then 1
①

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER?
①
31 blocks I figured out the base
and subtracted 2 blocks untel I got to 1

Part 3

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER? 24

Because 4x4 is 16 so 4x6 is 24. ①

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH?
HOW DID YOU FIGURE OUT YOUR ANSWER? ①

15
15
30
5

35, well I figured how much in each side then added them together then added the middle column

3) HOW MANY BLOCKS WOULD BE IN A STAIRCASE 6 BLOCKS HIGH
HOW DID YOU FIGURE OUT YOUR ANSWER? 21 (v).

I added 10 and (5) for the row of 5 after the four and (6) for the row of 6

Part 4

THIRD GRADE SCORE POINT 3

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100 by adding 55 + 45. ③

THIRD GRADE SCORE POINT 2

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100, add ②

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

at least 100, I added ②

Part 4

SEVENTH GRADE SCORE POINT 3

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER? ③

100 because you square the block height.

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER? ③

100 - same way as no. 3

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER? ③

100 blocks I did 10 x 10 which equals 100 because 6x6 = 36 and that is the right answer

Part 4

ELEVENTH GRADE SCORE POINT 3

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100 - multiply - 10 x 10. ③

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100 use the same process ③

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

You would need a 100 blocks
I times 10 by a itself ③

SEVENTH GRADE SCORE POINT 2

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

you would need 100 blocks ②

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100 ②

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100 blocks ②

Part 4

ELEVENTH GRADE SCORE POINT 2

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER? 102

10+18+16+14+12+10+8+6+4+2 ②

[Good method - just added wrong]

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER? ②

100

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

100 - because the ratios have to be the same 10:10 + 6:6 ②

Part 4

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

40 $\begin{array}{r} 10 \\ \underline{\times 4} \end{array}$ ①

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

60 blockes because you add ①
10x6=60 blockes

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

60 made one ①

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

152 blocks. I Figured it out by thinking how many more blocks would have to go. ①

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

55. I put 10-1 in rows and added them together ①

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

10 ①

ELEVENTH GRADE SCORE POINT 1

Part 4

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

79 I built it. ①

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

10x4= 40 blocks. ①

4) HOW MANY BLOCKS WOULD YOU NEED TO BUILD A STAIRCASE 10 BLOCKS HIGH? HOW DID YOU FIGURE OUT YOUR ANSWER?

10, there is a pattern. ①

Part 5

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

It is the # of stairs times itself = the # of blocks. ②

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

the number of blocks high is the square root of the total amount of blocks. ②

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

the relationship is that you take the height times the height again and that gives you how many blocks are needed if the height was five blocks high than you would need 25 blocks becouze 5×5 = 25. ②

Part 5

ELEVENTH GRADE   SCORE POINT 2

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ②

The relationship is height squared equals the number

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

The height of the staircase is how many blocks needed times it by itself ②

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

the height of the staircase determines the number of blocks. The height of the staircase multiplied by itself would give the total # of blocks. ②

Part 5

THIRD GRADE SCORE POINT 1

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ①

The all need an even number of blocks

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

You haveto add blocks ①

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

All you have to do is multiply ①

Part 5

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ①.

as the staircase gets taller, it needs more bricks.

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT?

you have to put a block in every row if you go up a number ①

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ①

There is the same amount on each side of the staircase.

Part 5

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ①

Ratio of Length to Height must be equal
and decline by 1 each block.

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ①

divide the number you get
by how high the blocks go, that'll
give you the relationship
of height to blocks needed

5) WHAT IS THE RELATIONSHIP BETWEEN THE HEIGHT OF ANY STAIRCASE AND THE NUMBER OF BLOCKS NEEDED TO BUILD IT? ①

Each one is multiplied by 4
and out comes the answer

Comments on Double Staircase (Grades 3, 7, and 11)

In this exercise, students need to derive a generalized formula to determine how many blocks are needed to build a staircase of any height. The students are intended to derive this formula (expressed either as a numerical equation or a statement) as they progress through a series of steps presented in the problem.

Students were provided with a permanently assembled "staircase" four blocks high and enough loose blocks to build the staircase up to one 6 blocks high, but not enough for one 10 blocks high. The "double staircase" was built with the two sides at right angles to each other so that, from the front, only the top block of the single column of 4 blocks shows. Thus, only 13 of the 16 blocks were visible from the front.

The inadvertent omission of a line for the response to the first question about the number of blocks in the staircase affected the data for that question, particularly at grade 3 where 50 percent of the students did not respond.

The exercise was too difficult for third-grade students. Of the 54 third graders who answered the first question, 23 were correct, 15 said 13 blocks, and 16 gave some other incorrect response. Very few responded correctly to any of the other parts of the exercise.

At grade 7, of the 100 students who answered the first question, 52 answered it correctly but 23 apparently ignored the hidden three blocks. In comparison, at grade 11, of the 84 who answered the question, 69 were correct and only 8 gave the response of 13 blocks. There is evidence of developmental change from seventh to eleventh grade in the sample data. For example, the maximum score on the 6-block question was achieved by 69 percent at grade 11 compared to 25 percent at grade 7. Fifty-nine percent of eleventh graders compared to 20 percent of seventh graders were successful in making the 10-block extrapolation. Sixty-four percent at grade 11 were able to make the generalization for any height compared to 19 percent at grade 7.

A minor change in wording was suggested for any future use; namely, to call this a two-way staircase and to ask in each question how many blocks are needed to build a two-way staircase like this. It also was suggested that the wording of the last question be tightened to avoid potential confusion about the term "any staircase." This exercise is recommended for future use in grades 7 and 11 with minor wording changes, but not for grade 3.

STATION 5

WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

HERE'S WHAT YOU DO:

1) LOOK CAREFULLY AT THE TUBES IN THE COLORED WATER. DO NOT REMOVE THEM FROM THE WATER.

WHAT DID YOU FIND:

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

NOW LOOK CAREFULLY AT TUBE X THAT IS ON THE TABLE. DO NOT PUT IT IN THE WATER.

EXPLAIN:

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

Activity Identification: Tubes and Capillarity

Grade(s): 7,11

Method of Administration: Self-Administered Station Activity

Content Area: Science-Biology, Chemistry

Apparatus required: Beaker containing colored water, five small open-ended glass tubes labelled A, B, C, D and E, of equal length but different interior diameters, and one open-ended glass tube labelled X of the same diameter as one of the five, a six-inch ruler (Administrator should make sure that only five tubes are placed in the water. The sixth tube should be placed along side but not in the beaker and should match the size of one of the five tubes in the solution.) The dish should be filled up to the top before every administration. Stock liquid should be kept out of view of the student.

Administration: All materials should be set on a mat of white paper. Tubes A, B, C, D, and E should be lined up next to each other in the beaker of colored water. Students should be reminded not to take these tubes out of the water. Tube X should be placed alongside but not in the beaker. Tubes should be dried off, if necessary at the end of each administration. The fluid level in the beaker should be at a constant level for all administrations. Concluding each session, all tubes should be cleaned with water and then with acetone.

Servicing: None required

Tubes and Capillarity
Station B
Grade 7 - station 5
11 - station 5

Scoring of the Written Responses

2) Score 3 pts. if the student makes an accurate generalization about the relationship between the diameter of the tube and how far the liquid travels up it. Score 2 pts. if the student makes an accurate statement about how far the liquid will travel up a given tube or set of tubes, without making a generalization across all tubes. Score 1 pt. if the student provides an erroneous generalization, an irrelevant response or a description only. Score 0 if the student makes no response.

3) Score 3 pts. if the student provides a plausible hypothesis about how far up the tube the liquid will travel and why. Score 2 pts. if the student provides a plausible explanation or prediction but not both. Score 1 pt. if the student provides an inaccurate explanation or prediction or both. Score 0 if the student provides no response.

Skills involved

In this exercise the student needs to note the relationship between two variables. This relationship can be deduced by making detailed observations, by noting how changes in the independent variable affect changes in the dependent variable, and then, by deriving a generalization for an "unknown."

Part 2

SEVENTH GRADE SCORE POINT 3

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

3

The tube with the wider tube inside absorbed the most liquid but the thinner it was the higher it went

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

3

The skinnier the hole in the tube, the farther up the liquid goes.

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

3

there is different spaces in each tube, the one with less space, the water goes up higher

Part 2

ELEVENTH GRADE SCORE POINT 3

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

They all have various sized openings or funnels; the higher the water level, the narrower the funnel ③

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

the narrower in diameter the inner holes of the tubes are, the higher the liquid goes up them. ③

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

The thinner the central cylinder of the tube, the farther up the liquid goes ③

Part 2 -

SEVENTH GRADE SCORE POINT 2

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

It goes half way up them

② .

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

The tubes are all different sizes the liquid goes up all of them the same amount.

②

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

About Halfway

② .

Part 2

ELEVENTH GRADE SCORE POINT 2

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

the tubes have different widths and according to how skinny the tube is, the water goes above the level of the H_2O in the container

2

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

The liquid goes up in the tube at different heights. All are different

2

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM? The 2 tubes are longer

The liquid just goes up to the normal level of the tubes - it is an optical illusion which tries to fool you into thinking the liquid would go up higher on the tube - but it doesn't. The 2 tubes to the far left have liquid up further than the rest - they have the large holes on them

2

Part 2

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

the liquid goes up about the same. It seems as though the liquid went up farther than it really does

①

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

the one with the wider hole the watter went up higher

①

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

Just a little bit.

①

Pa 2

ELEVENTH GRADE SCORE POINT 2

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

THE THICKER THE TUBE, THE HIGHER THE WATER LEVEL

(1)

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

The liquid goes further up some

(1)

2) WHAT DO YOU NOTICE ABOUT THE TUBES, AND HOW FAR THE LIQUID GOES UP THEM?

all the tubes are filled to a certain point w/ blue water, except the 1st which is filled a littlebit less (the 1st has a hollow top; the others, sealed)

(1)

Do NOT PUT IT
the first also has
a completely
hollow center

Part 3

SEVENTH GRADE SCORE POINT 3

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X?
WHY DO YOU THINK SO? ③

I think it will go half way up because the tube inthe center is about the same as one of the tubes inthe liquid

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X?
WHY DO YOU THINK SO?

about 60 cm, because there is a tube about the same size and it is about 60 cm. ③

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X?
WHY DO YOU THINK SO? ③

Lower than the ones in the liquid because it looks a little thicker.
the hole

Part 3

ELEVENTH GRADE SCORE POINT 3

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

IT WOULD GO UP ABOUT A CM. THAT IS HOW FAR THE MIDDLE TUBES WATER LEVEL ROSE, AND THE TUBE X HAS A TUBE WITH APPROXMATELY THE SAME DIAMETER. ③

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

About 60 ml ; it looks like it has probably the same sized opening as C ③.

held vertical	A-narrowest -	90 ml
	B	70
	C	60
	D	45
	C-widest	40

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

The liquid in tube x would go up 60 mm because it's hole is about equal in diameter to the hole in the middle tube. ③

Part 3

SEVENTH GRADE SCORE POINT 2

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X?
WHY DO YOU THINK SO?

It would go halfway. ②

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? ②
WHY DO YOU THINK SO?

It would go up tube X
the same length as the other
because it doesn't matter
how long it is.

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X?
WHY DO YOU THINK SO?

Not as much because ②
it is longer. The water came to
go up less for the longer
ones.

Part 3

ELEVENTH GRADE SCORE POINT 2

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

I would expect it to go about 3/4 of the way up because it is the average. (80 mm) approx. ②

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

because the tube is very skinny, the water should rise in the tube very high, about 3/4 of the whole tube, (4/5 cm above the level of water) ②

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

I would expect the water to rise very high for it would [illegible] the [illegible] the [illegible] why this occurs is because the [illegible] the inside the more surface for the water to cling to the glass for the [illegible] ②

Part 3

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

about 1 1/2 mm above surface, same as lowest one

1

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

About the same as the others, they are the same size.

1

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

Half way because it is the same as the others & the other ones did that

1

Part 3

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

Almost completely to the top of the tube because the hollowed-out part is so thin. ①.

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

I think the blue water in tube X would go up to the same point as the other because it is similar to the others. (except tube #1) ①.

3) HOW FAR WOULD YOU EXPECT THE LIQUID TO GO UP IN TUBE X? WHY DO YOU THINK SO?

I don't think it would go up the tubes. The air hole in the 3 tubes which water up them is very large whereas all the others have small holes. Tube X also has a small hole ①'

Comments on Tubes and Capillarity (Grades 7 and 11)

In this exercise, students were asked to make observations about the height of colored water in 5 tubes. Each of the tubes had a different interior diameter. The students were expected to infer the relationship between water height and interior diameter. Finally, students had to apply this relationship to predict how high water would rise in a tube with an interior diameter that was the same as one of the original five tubes.

Students at both grade levels seemed to understand this task and the results indicated improved performance from grade 7 to 11. For the second part of the exercise, accurate observations were made about the height of the water in the tubes by 50 percent of the seventh graders and by 73 percent of the eleventh graders. Statements about the relationship between the height and interior diameter were made by 22 percent of the seventh graders and 39 percent of the eleventh graders.

For the third part of the exercise, accurate hypotheses about how high the water would rise in tube X and the reasons why were provided by 29 percent of the seventh graders and by 33 percent of the eleventh graders. A hypothesis without a reason was made by an additional 21 percent of the seventh graders and 41 percent of the eleventh graders.

The administrators reported that the students had trouble with the apparatus. The liquid was difficult to see which made the height of the liquid in the tubes very difficult to determine. If students removed the tubes from the liquid, the exercise was usually confounded because the tubes with fine inner diameters can become "air bound." If the tubes are moved within the liquid , the levels can change in the tubes. It was the consensus of the advisory panel that the exercise needs a liquid that is easier to see and instructions that are more explicit. The tubes should be fixed for easier observation and measurement. The students should not be able to move or remove the tubes.

The exercise did show that many seventh and eleventh graders in the sample could observe and report a relationship between two variables. The equipment is small, but tricky to set up and difficult to maintain. This exercise may be appropriate for a future national assessment if it is revised and the equipment is changed. The panel recommended that it not be used as pilot tested.

STATION 4

YOU HAVE BOXES LABELLED A,B,C,D, AND E. USE THE CIRCUIT TO TEST THE BOXES.

DETERMINE WHAT EACH BOX CONTAINS AND WRITE DOWN THE LETTER OF THE BOX ON THE BLANK LINE. THERE IS ONE THING LISTED BELOW WHICH IS NOT IN ANY BOX. LEAVE THAT SPACE BLANK.

WHICH BOX CONTAINS:

__ 1. A PIECE OF WOOD?

__ 2. A VARIABLE CONDUCTOR? (SOMETHING THAT CONTROLS THE RATE OF CURRENT THROUGH THE CIRCUIT)

__ 3. A RESISTOR? (SOMETHING THAT LIMITS THE CURRENT THAT CAN PASS THROUGH THE CIRCUIT)

__ 4. A BATTERY?

__ 5. A PIECE OF COPPER WIRE?

__ 6. A DIODE? (SOMETHING THAT ONLY LETS THE ELECTRICITY PASS THROUGH THE CIRCUIT IN ONE DIRECTION)

Activity Identification: Conductivity

Grade(s): 11

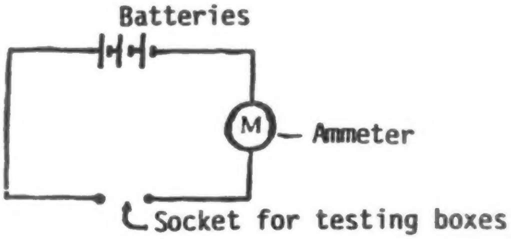
Method of Administration: Self-Administered Station Activity

Content Area: Science-Physics

Apparatus required: Five sealed black boxes labelled A-E containing the following materials: A = a piece of copper wire, B = a resistor, C = a piece of wood, D = a diode, E = a micro relay; one circuit, set up with three 1.5-volt batteries in holder, an ammeter, and socket for testing the boxes; three spare batteries. Apparatus for circuit should be set up as shown in the diagram below.

Administration: The circuit should be set up as specified in the diagram within the Conductivity box with boxes A-E placed alongside it. No box should be left in contacts at the end of each administration. Circuits should be checked after every administration to see if they are still connected.

Servicing: None required



Conductivity
Station B
Grade 11 - station 4

Scoring of the Written Responses

1-6) Score 1 point for every correct answer. Scoreable answers should include the following sequence of responses:

1. C
2. E
3. B
4. —
5. A
6. D

Note: The student should be scored for having left 4 blank but only when she or he has filled in all the other responses.

Skills involved

In this exercise the student needs to determine a set of answers based on her or his available content information and information presented within the context of the problem.

ELEVENTH GRADE SCORE POINT 6

WHICH BOX CONTAINS:

C 1. A PIECE OF WOOD?

E 2. A VARIABLE CONDUCTOR? (SOMETHING THAT CONTROLS THE RATE OF CURRENT THROUGH THE CIRCUIT)

B 3. A RESISTOR? (SOMETHING THAT LIMITS THE CURRENT THAT CAN PASS THROUGH THE CIRCUIT)

6

__ 4. A BATTERY?

A 5. A PIECE OF COPPER WIRE?

D 6. A DIODE? (SOMETHING THAT ONLY LETS THE ELECTRICITY PASS THROUGH THE CIRCUIT IN ONE DIRECTION)

ELEVENTH GRADE SCORE POINT 4

WHICH BOX CONTAINS:

C 1. A PIECE OF WOOD?

~~B~~ 2. A VARIABLE CONDUCTOR? (SOMETHING THAT CONTROLS THE RATE OF CURRENT THROUGH THE CIRCUIT)

~~E~~ 3. A RESISTOR? (SOMETHING THAT LIMITS THE CURRENT THAT CAN PASS THROUGH THE CIRCUIT)

(4)

_ ~~4. A BATTER~~Y?

A 5. A PIECE OF COPPER WIRE?

D 6. A DIODE? (SOMETHING THAT ONLY LETS THE ELECTRICITY PASS THROUGH THE CIRCUIT IN ONE DIRECTION)

ELEVENTH GRADE SCORE POINT 3

WHICH BOX CONTAINS:

C 1. A PIECE OF WOOD?

E 2. A VARIABLE CONDUCTOR? (SOMETHING THAT CONTROLS THE RATE OF CURRENT THROUGH THE CIRCUIT)

3. A RESISTOR? (SOMETHING THAT LIMITS THE CURRENT THAT CAN PASS THROUGH THE CIRCUIT) ③

~~A~~ 4. A BATTERY?

~~B~~ 5. A PIECE OF COPPER WIRE?

D 6. A DIODE? (SOMETHING THAT ONLY LETS THE ELECTRICITY PASS THROUGH THE CIRCUIT IN ONE DIRECTION)

ELEVENTH GRADE SCORE POINT 2

WHICH BOX CONTAINS:

C 1. A PIECE OF WOOD?

? ~~B~~ 2. A VARIABLE CONDUCTOR? (SOMETHING THAT CONTROLS THE RATE OF CURRENT THROUGH THE CIRCUIT)

? ~~E~~ 3. A RESISTOR? (SOMETHING THAT LIMITS THE CURRENT THAT CAN PASS THROUGH THE CIRCUIT) ②

~~A~~ 4. A BATTERY?

~~_~~ 5. A PIECE OF COPPER WIRE?

D 6. A DIODE? (SOMETHING THAT ONLY LETS THE ELECTRICITY PASS THROUGH THE CIRCUIT IN ONE DIRECTION)

A - 100 L + R

B - can move back + forth, be contidled

C - constant on L + R

D = Constant on L 100 on R

E - Back and forth from 5-25 on L + R

ELEVENTH GRADE SCORE POINT 1

WHICH BOX CONTAINS:

D 1. A PIECE OF WOOD?

E 2. A VARIABLE CONDUCTOR? (SOMETHING THAT CONTROLS THE RATE OF CURRENT THROUGH THE CIRCUIT)

C 3. A RESISTOR? (SOMETHING THAT LIMITS THE CURRENT THAT CAN PASS THROUGH THE CIRCUIT)

A 4. A BATTERY?

B 5. A PIECE OF COPPER WIRE?

6. A DIODE? (SOMETHING THAT ONLY LETS THE ELECTRICITY PASS THROUGH THE CIRCUIT IN ONE DIRECTION)

①

Comments on Conductivity (Grade 11)

In this exercise, students were asked to determine the identity of five unknown materials. Students had to conduct tests with an electric circuit and infer which of the unknowns were a piece of wood, a variable conductor, a resistor, a battery, a piece of copper wire, and a diode.

The correct identity for all unknowns was selected by 33 percent of the students. The most common errors were made between the wood and the diode, the wire and the battery, and the wood and the resistor. The advisory panel hypothesized that the wood and diode error might have resulted from students testing only some of the unknowns and hence, reaching erroneous conclusions. The wire and battery error might arise because students may not have knowledge of the workings of batteries and wires.

It was the consensus of the advisory panel that the electrical apparatus was too content or experience oriented. This view was supported by the gender differences in the data. Forty-six percent of the males compared to 20 percent of the females in the sample correctly identified all the unknown materials. It was suggested that one common item, such as heavy household wire with the ends exposed, be provided to illustrate what happens on the meter when the material tested carries electricity. The panel felt that if more explanation of the apparatus is included, the exercise could be administered to seventh graders as well as to eleventh graders.

The administrators reported that students liked "experimenting" with the apparatus. Also, the results showed that some students were able to solve the problem. The equipment is small, and with proper instruction, it is very easy to set up and maintain. If it is revised as suggested, this exercise would be appropriate for use with eleventh and possibly seventh graders in a future national assessment.

STATION 4

YOU ARE GOING TO PLAY THE GUMBALL GAME WITH THE COMPUTER. THE COMPUTER WILL TELL YOU WHAT TO DO AND YOU WILL PUT ALL YOUR ANSWERS INTO THE COMPUTER.

Activity Identification: Gumballs

Grade(s): 3,7,11

Method of Administration: Self-Administered Station Activity/Computer

Content Area: Mathematics-Probability

Apparatus required: Apple II Series Computer with 48k memory, diskette with program, paper and pencil.

Administration: Administrator should type in the student's code at the onset of each administration and reset the program at the end of each administration.

Servicing: None required

Remember
Press the RETURN key after you
enter a number or answer a question.

Self-Administered Station Activity- 3,7,11

Does the jar have more red gumballs or more green gumballs? Pick some gumballs.

Press the number of gumballs you want on the keyboard.

(For grade 3)
You can pick any number from 1 through 10.

(For grades 7 & 11)
You can pick any number from 1 through 100.

(After the student has selected a number) **You got** (some number) **red gumballs and** (some number) **green gumballs.**

Note: Computer screen will then show how a sample record of the student's responses will look (see example below)

Draw	Red	Green
1	6	3

This is a record of your pick.

The computer will give you six turns.
Press R when you are ready to play.

(After the student has pressed R)
Pick some gumballs.
How many do you want?
Press the number on the keyboard.

(After the student has made a response) **You got** (some number) **red gumballs and** (some number) **green gumballs.**

Note: A record of the student's picks will be kept in the right hand corner of the screen. This record will always be available for the student to see.

The program will proceed in the manner above for 6 draws. After the sixth draw the student will be given the prompts to determine whether the jar has more red gumballs or green gumballs and what this ratio is.

Does the jar have more red gumballs or green gumballs? Press R if there are more red gumballs. Press G if there are more green gumballs.

(After the student has made a response) **You answered that the jar has more** (red/green) **gumballs.**

Fill in the blanks in this sentence by pressing the numbers on the keyboard which will make the sentence read what you think the ratio is.

(For grade 3)
For every two red gumballs in the jar there are (some number) **green gumballs.**

(For grades 7 & 11)
The ratio of red gumballs to green gumballs is (some number) **red to** (some number) **green.**

(Note: The ratio for grade 3 will be 2 red gumballs to 1 green gumball. The ratio for grades 7 & 11 will be 3 red gumballs to 2 green gumballs.)

Good game. Thanks for playing the Gumball Game.

Comments on the Gumball Game (Grades 3, 7, 11)

This is a computer-administered task in which the students are expected to use the results from a series of draws to determine whether there are more red or green gumballs in the jar and the ratio of red to green. The student designates each time the number of gumballs to be drawn, the computer makes random picks and reports the number of red and of green obtained. For grade 3, the computer was programmed to pick up to 10 from a jar with a 2:1 ratio of reds to greens. For grades 7 and 11, the program allowed for picks up to 100 per draw from a jar with a 3:2 ratio of reds to greens.

As with the other computer-administered tasks, a significant portion of the data was lost. The problem may have been caused by differences between computers or lapses between administrations. It was not due to the program. All the grade 7 and 11 programs were copied from the same master disk. Administrators reported, in most cases, that the program ran and all students did the tasks.

The number of usable cases for grade 3 are only 41; for grade 7, there are 92; for grade 11, 59. In comparison, the number of students who were administered the Gumball Game was 110 at grade 3, 120 at grade 7, and 101 at grade 11.

Despite the small number of responses, a 5-part alphabetic classification was created for tracking the students' strategies in drawing gumballs. It appears that the task was appropriate even at the youngest grade level. Of the third graders for whom there is data, most varied their requests between high and low although none requested the maximum number on all drawings. A larger percent was able to complete this task than the Circle Game. Only 5 students did not answer the first question and 80 percent responded correctly that there were more red gumballs. On the other hand, the third graders did not understand the question about the ratio as it was phrased without using the term and none answered this question correctly. Clearly, the second question as worded is not appropriate for third grade.

With respect to the ratio question for grades 7 and 11, when students drew low numbers most of the time, the record did not imply the expected 3:2 ratio. Because the computer had been programmed to complete and print out the average number of reds and greens obtained, it was decided to use the record and to accept as correct not only 3:2, but any ratio close to the ratio of the averages actually obtained. When the student gave as the ratio the sums of the numbers of reds and greens obtained in all the tries, the responses were classified in a separate score level.

Although the idea for this task is good and students can understand how to do the task, the program needs reworking. The advisory panel suggested that the program should be more directive at the beginning and that students should be told that they are looking for a ratio. The program also needs a definition of the sample space (i.e. how many gumballs in the jar) and information on whether the sampling is with replacement after each drawing. For grade 3, either the program should stop at the "more reds than greens" stage or try asking the ratio question in the form of a prediction: "If you now picked 9 gumballs, how many reds would you expect to get?" For grades 7 and 11, rewording was suggested to say, "the ratio of red gumballs to green gumballs probably was _____ red to _____ green."

The revised programs would require pilot testing at all three grades before operational use.

STATION 4

YOU HAVE BEEN GIVEN SOME BUBBLE WANDS.

THE WANDS MAKE DIFFERENT KINDS OF BUBBLES IN DIFFERENT WAYS.

HERE'S WHAT YOU DO:

1) TAKE EACH WAND, AND BLOW THROUGH IT TO MAKE BUBBLES.

WHAT DID YOU FIND:

2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE			
SMALL CIRCLE			
LARGE SQUARE			
LARGE CIRCLE			

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

STATION 4

You have been given some bubble wands. The wands make different kinds of bubbles in different ways.

Here's what you do:

1) Take each wand and blow through it to make bubbles.

What did you find:

2) Write down what you find out about how the wands make bubbles. Put this information in a table. In your table include information about how many bubbles were made by each wand, how big the bubbles were, and the shapes of the bubbles.

Explain what you found:

3) Look back at your table.

4) What happens to the number and size of the bubbles as the wand gets larger?

5) What happens to the number and size of the bubbles as the shape of the wand changes?

Activity Identification: Bubbles

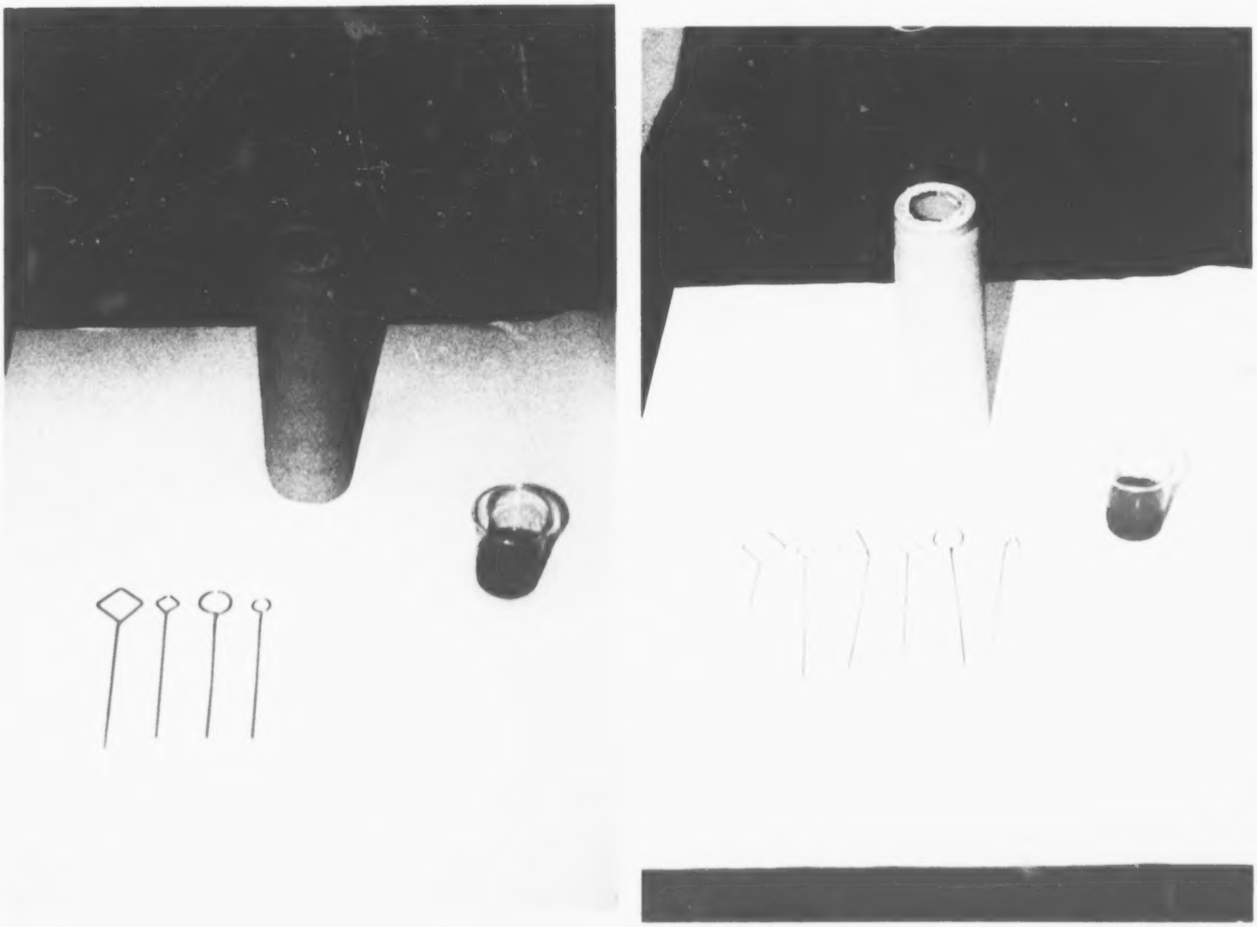
Grade(s): 3,7,11

Method of Administration: Self-Administered Station Activity

Content Area: Mathematics-Geometric Relationships

Apparatus required: Small and large bubble wands of different shapes (square, circular, and triangular); paper towels, 1 small bottle of bubble mixture (containing dishwashing liquid and water), paper and pencil. For grade 3 students only the square and circular wands will be used.

Administration: Bubble wands should be placed on a wad of paper towels before the onset of each administration. Administrators should make sure that the students blow the bubbles away from other students and their own papers. Bubble mix should be filled half-way before the onset of each administration. Stock liquid should be kept out of view of the student.
Servicing: None required



Bubbles
Station A
Grade 3 - station 4
7 - station 4
11 - station 4

Scoring of the Written Responses

(for grade 3)

2) Score 2 pts. if the student completes the table of findings. Score 1 pt. if the student provides an incomplete table of findings. Score 0 if the student makes no response.

(for grades 7 & 11)

2) Score 3 pts. if the student makes a complete table of her or his findings. (Note: This table should be comparable to that already provided for the grade 3 students). Score 2 pts. if the student provides an incomplete table of her or his findings. Score 1 pt. if information is provided in a non-tabular form. Score 0 if the student makes no response.

(for grades 3, 7 & 11)

4) Score 4 pts. if the student specifies the relationship between size of the bubble wand and the number and size of the bubbles made that is consistent with the table. Score 3 pts. if the student specifies the relationship between the number and size of the bubbles made that is inconsistent with the table. Score 2 pts. if the student makes specific statements about how the size of the wand influences the number or size of the bubbles that is consistent with the table. Score 1 pt. if the student provides an irrelevant or non-specific statement. Score 0 if the student makes no response.

(for grades 7 & 11)

5) Score 5 pts. if the student specifies the relationship between the shape of the bubble wand and the number and size of the bubbles made that is consistent with the table. Score 4 pts. if the student specifies the relationship between the shape of the bubbles wand and the number and size of the bubbles made which is inconsistent with the table. Score 3 pts. if the student makes a specific statement about how the shape of the wand influences the number or size of the bubbles that is consistent with the table. Score 2 pts. if the student makes a specific statement that is inconsistent with the information in the table. Score 1 pt. if the student provides an irrelevant or non-specific statement. Score 0 if the student makes no response.

Note: Specific statements are presumed to be correct statements.

Skills involved

In this exercise students must record (and for the grade 7 and 11 students, organize) a set of findings. Based on these findings the students must then make a generalization about how changes in the independent variable bring about changes in the dependent variable. These generalizations should be based on comparisons and contrasts of the findings.

text 2

THIRD GRADE SCORE POINT 2

2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE	1	large	circle
SMALL CIRCLE	2	mediam	circles
LARGE SQUARE	1	small	square
LARGE CIRCLE	1	large	circle

②

2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE	1	very small	round
SMALL CIRCLE	1	small	round
LARGE SQUARE	1	very big	round
LARGE CIRCLE	1	large	round

②

2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE	1	small	circle
SMALL CIRCLE	2	small	circle
LARGE SQUARE	1	big	circle
LARGE CIRCLE	2	big	cirle

②

Part 2

SEVENTH GRADE SCORE POINT 3

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

	How Many	How Big	Shapes
L □	1	large	round
S O	4.	small	round
L △	1	large	round
S □	3	small	round
L O	1	large	round
S △	4	small	round

3

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

Wand	Number	Size	Shape
Large Diamond	3	Large	Round
Small circle	9	Small	Round
Large Triangle	2	Large	Round
Small diamond	5	small	Round
Large Circle	1	Large	Round
Small ~~diamond~~ triangle	4	small	Round

3

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

shape	◇	○	△	◇	○	△
how many bubbles	3	4	2	8	3	10
size	pretty big	small	very large	small	big	small
shape	⬯ ○	○○○	⬯	○○	○	○○○○○

3

Part 2

ELEVENTH GRADE SCORE POINT 3

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

	Big Square	Little Circle	Big Triangle	Little Square	Big Circle	Little Triangle
Bubbles	1	2	1	2	1	2
How big	small	big	Small	big	small	big
Shape	small	big	small	big	small	big

③

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

	big ◇	○ small	△ big	small △	◇ small	big ○
# bubbles	1.	3.	2	6-7	3	1
Big	medium	Varied	Varied	small medium	small	Big
Shape	Bubble	Bubble	Bubble	Bubbles	Bubbles	Bubble

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

	# bubbles		
◇	5	big	round
○	4	small	vound
○	5	big	vound
◇	3	small	vound
○	4	med	vound
○	5	med	vound

③

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT YOUR TABLE.

Part 2

SEVENTH GRADE SCORE POINT 2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

b#1 · big · squares with rounded edges · 4
b#2 smalle round · 5
b#3 medium · circle -1
b#4 small · circle - 4
b#5 small rond - 4

2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

small trianguler wand-made circular bubbles, 1 bubble small
big circle wand- made 1 big circular buble
Diamond chaped wand - made 6 circular bubbles
Big triangular wand - made 1 big bubble
small circular wand - made 6 small bubbles
Big triangular wand-made 1 big bubble

2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

	How many Bubbles	H.B	Shape	
diamond shape	2	medium	circle	
circle shape	4 - 6	small	circle	
triange			''	
small diamond			''	
big circle		Big	circle	
little triangle				

2

Part 2

ELEVENTH GRADE SCORE POINT 2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

# of Bubbles	size	shape
2	Large	round
1	small	round
1	couldn't tell	couldn't tell
1	small	round
1	small	round
\	couldn't tell	couldn't tell
1		

2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

Bubble #:	Size	Shape
1		round
4	lg	round
1	lg	round
1	sm	round
7	sm	round
0	—	—

2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

	#.	SIZE	SHAPE
1	None	—	—
2	one	small	round
3	none	—	—
4	one	BIG	round
5	none	—	—

2

Part 2

THIRD GRADE SCORE POINT 1

2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE			
SMALL CIRCLE	2	✓	✓
LARGE SQUARE		✓	
LARGE CIRCLE	✓	✓	

①.

2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE	3		circle
SMALL CIRCLE	1	big	circle
LARGE SQUARE	2	big	circle
LARGE CIRCLE	1	very big	circle

①.

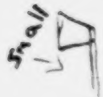
2) WRITE DOWN WHAT YOU FIND IN THE TABLE BELOW.

TYPE OF BUBBLE WAND	NUMBER OF BUBBLES	SIZE OF BUBBLES	SHAPE OF BUBBLES
SMALL SQUARE	4	big	
SMALL CIRCLE	5	big	
LARGE SQUARE	1	big	
LARGE CIRCLE	0	big	

①.

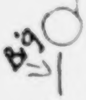
SEVENTH GRADE SCORE POINT 1

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

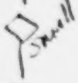


bubbles small about 15 bubbles the Bubbles were circle

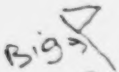
1



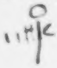
not any bubbles



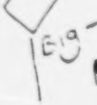
there were about 10 bubbles Medium size circle



no bubbles



no bubbles



-about 4 bubbles Medium circle

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

1

tha Smallertha WanD the smallar tha bubblas. More bubbles cama out tha smallar and ONa big bubblas comas out the Big wands

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

The make some little & some big. More than just 1 bubble goes through some at a time.

1

ELEVENTH GRADE SCORE POINT 1

[illegible] 2

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

The smaller wands made more but smaller bubbles which came out in different size bubbles The bigger wands made less bubbles, but the bubbles were bigger.

①

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.

1 It was a huge bauble

2 small

3. Was just a regular size bauble.

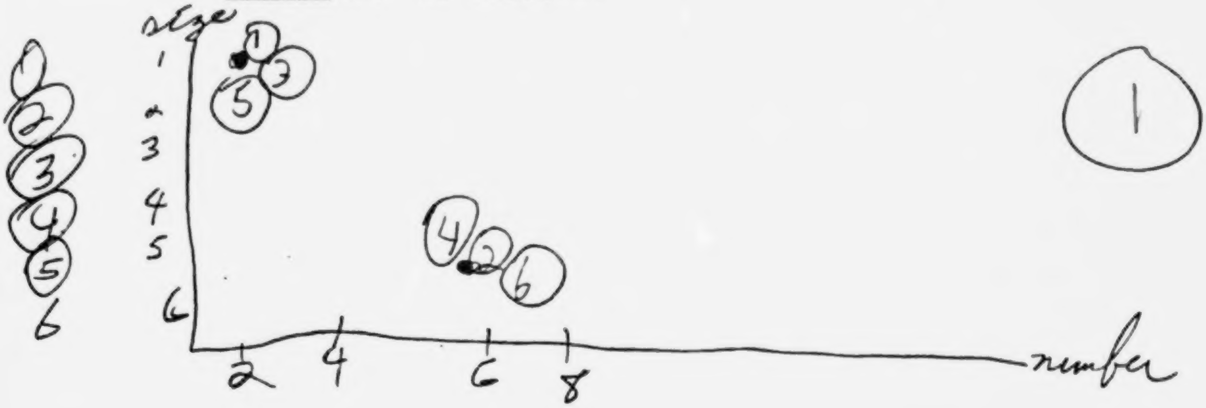
4 It formed better than the rest

5 There were more baubles that came out

6. More smaller bubbles.

①

2) WRITE DOWN WHAT YOU FIND OUT ABOUT HOW THE WANDS MAKE BUBBLES. PUT THIS INFORMATION IN A TABLE. IN YOUR TABLE INCLUDE INFORMATION ABOUT HOW MANY BUBBLES WERE MADE BY EACH WAND, HOW BIG THE BUBBLES WERE, AND THE SHAPES OF THE BUBBLES.



①

Part 4

THIRD GRADE SCORE POINT 4

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

it makes less bubbles and makes larger ones. ④

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

As the wand gets larger the bubbles get smaller. And the number gets smaller, ④

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles got big and sometimes two ④

Part 4

SEVENTH GRADE   SCORE POINT 4

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

less bubbles, bigger size

4

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

When the wand gets larger the bubbles become larger, but the number decreases.

4

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles are bigger but there are less bubbles

4

Part 4

ELEVENTH GRADE   SCORE POINT 4

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

AS THE WAND GETS LARGER THE NUMBER DIMINISHES AND THE SIZE INCREASES.

(4)

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

the bubles get larger but there are not as many,

(4)

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The number decreases and the size increases

(4)

Part 4

THIRD GRADE SCORE POINT 3

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

the size gets biger by the size of the wand and you can blow more babbles by having a bigger wand.

3

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

They get biggen and more come out

3

Part 4

SEVENTH GRADE SCORE POINT 3

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

About 1 bubble comes out but it comes out large.

③.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles get a lot larger

③.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

get larger

③.

Part 4

ELEVENTH GRADE SCORE POINT 3

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

the bubbles get bigger in size and the # of bubbles remain fairly constant.

③

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

They get smaller

③

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The numbor & the size of the bubbles gets larger when the wan ddwes

③

Part 4 1

THIRD GRADE SCORE POINT 2

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER? ②

The size of bubble gets larger.

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles get much bigger. ②

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

When the wand gets bigger the bubble gets bigger. ②

Part 4

SEVENTH GRADE SCORE POINT 2

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

There are not as many bubbles and the size gets ~~smaller~~ larger.

(2)

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles get bigger as the wand gets larger.

(2)

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles get bigger in size and in the smaller ones get smalle

(2)

Part 4

ELEVENTH GRADE SCORE POINT 2

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The bubbles get smaller ②

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

THE BUBBLES TEND TO GET LARGER ②

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

the size gets bigger and the number doesnt have conclusive evidence ② task 1.4

THIRD GRADE SCORE POINT 1

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

It got biger ①

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

the bubble gets smaller ①

EXPLAIN WHAT YOU FOUND:

3) LOOK BACK AT THE NOTES IN YOUR TABLE.

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER? ①

The less bubbles you get.

SEVENTH GRADE SCORE POINT 1

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER? ①

it decreaces

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

Bigger bubbles

①

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER? ①

decreases

Part 4

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The number decreases then it stays the same. ①

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

The size and number varius from different ~~[illegible]~~ Wands. ①

4) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE WAND GETS LARGER?

size varies while number of bubbles increases in a circular wand and decreases in diamond shape wand. ①

THIRD GRADE SCORE POINT 4

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

same thing as above ④

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

they stay about the same ④

Part 5

SEVENTH GRADE SCORE POINT 5

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

They change sizes in different shapes, depending on how large the wand is. The number stays about the same, averaging 3 To 4 bubbles a blow.

5

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

the small ones have more
the Big ones have Big Bubbles +
the small ones have small Bubbles

5

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

5

The size of the wand made the bubbles large or small (Large = Large)
The number of bubbles decreased with large wands and increased with small wands

Part 5 1

ELEVENTH GRADE SCORE POINT 5

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

There are a lot of bubbles when the wand is small and the bubbles are all different sizes as we at big the # of bubbles decreases but the size increases ⑤

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES? ⑤

is ~~acts~~ inversely
size is directly — related to
[illegible] wand size

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The size decreases with the smaller wand change. Also, number increases with the decrease in size of wand. ⑤

Part 5

SEVENTH GRADE SCORE POINT 4

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

smaller wand - more bubbles
smaller size. Bigger Wand - less bubbles
bigger size

(4)

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

the number increases and
the size decreases

(4)

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

it increses but gets smaller
when the wands are little

(4)

Part 5

ELEVENTH GRADE SCORE POINT 4

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

Small and a larger number of bubbles.

4

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

4

The shapes of the wand produces different amount of bubbles depending On the size of the wand head

Part 5

THIRD GRADE SCORE POINT 3

~~bubble~~ 5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

~~by having a bigger wand.~~

bubbles get bigger ③ with big wands and you can blow more with a small wand.

Part 5

SEVENTH GRADE SCORE POINT 3

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

whan the shape of the wand changes the # does & the bubbles get bigger/smaller

3

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

3

The numbers change, but the shape stays pretty much the same circle.

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

They are all circles so it depends how big the wand is.

3

Part 5

ELEVENTH GRADE SCORE POINT 3

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The # of & size of the bubbles remains constant when the shape of the wand changes ③

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The ○ and ◇ shaped ones worked best and made the most bubbles. ③

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The smaller the wand the more bubbles ③

Part 5

THIRD GRADE SCORE POINT 2

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

When the wand changes the bubble either gets larger on smaller.

2

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

They stay the same shape and they get bigger.

2

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

Nothing

2

Part 5

SEVENTH GRADE SCORE POINT 2

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

It get smaller or bigger

②

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

the more rounded the wand is, the more bubbles form

②

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

the shape of the buble stays the same and as you get larger. the bubles will to

②

Part 5

ELEVENTH GRADE SCORE POINT 2

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The smAller; the more And smAller the bubbles Are ②

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The rounder the wand - the more bubbles ②

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

They began to change, & more were blown. ②

Part 5

THIRD GRADE SCORE POINT 1

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

it gets lower and lower ①

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

It stays the same shape as the wand. ①

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

it makes more bubble and makes smaller ones. ①

Part 5

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

As it becomes smaller, the bubbles become smaller. The number increases. ①

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

There are more bubbles but some of them turn ito larger ones ①

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

some of the larger ones didnt have any bubbles and the size didnt change much ①

ELEVENTH GRADE SCORE POINT 1 Part 5

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The number and size also changes ①

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

The bubbles get smaller, and some diminish so quick you can't tell the shape of it. ①

5) WHAT HAPPENS TO THE NUMBER AND SIZE OF THE BUBBLES AS THE SHAPE OF THE WAND CHANGES?

~~s~~ It stays the same ①

Comments on Bubbles (Grades 3, 7, and 11)

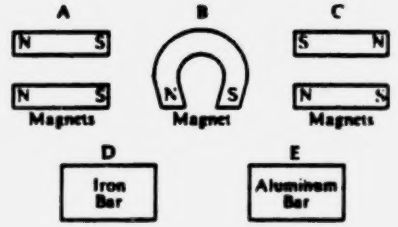
The Advisory Panel agreed that the Bubbles apparatus was not an appropriate basis for collecting data because the apparatus yielded very inconsistent findings. For example, it may have been difficult for students to control the rate of blowing through each of the wands or the viscosity of the solution between trials. Thus it would be unduly difficult for students to interpret their results.

However, the data indicates that 86 percent of the third grade students completed the table of information based on their findings. Similarly, 34 percent of the seventh graders and 68 percent of the eleventh graders made and completed their own table of findings. Also, the consultants agreed that exercises which tap the ability to collect and organize data are needed.

Therefore, a recommendation for future use might be that questions comparable to those posed in this exercise be asked with different materials that produce more consistent results.

STATION 6

Box X contains one of the following sets of objects.



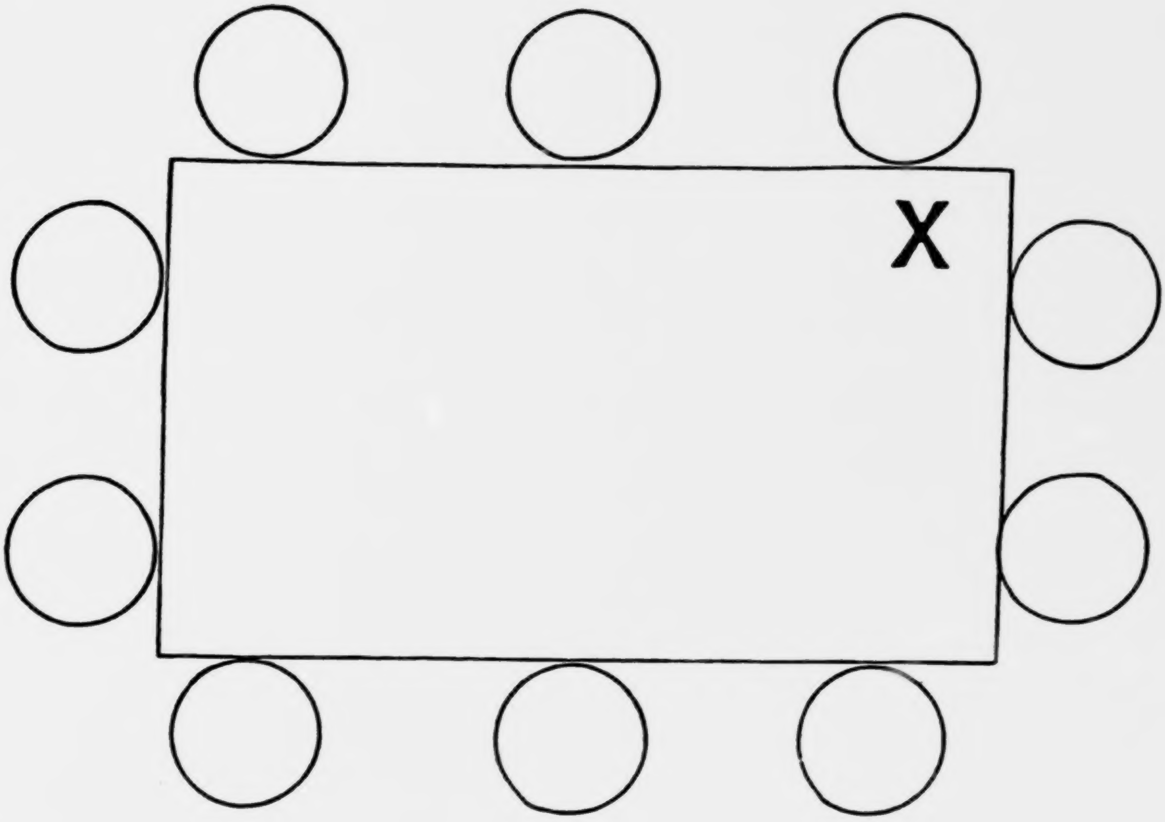
The set of objects is fixed firmly but not necessarily in the position shown above.

Here's what you do:

1. Put box X on the rectangle drawn on the attached page, with the letter X to the right as shown.
2. Put a compass on each circle in turn and draw an arrow in the circle showing the direction that the needle points.
3. Take the box off the paper.
4. From the direction of the arrows, work out which set of objects is in the box.
5. The set of objects that is in box X is:

   A __ B __ C __ D __ E __

6. Draw clearly in the rectangle on the attached page how your chosen set of objects is placed in box X.
7. Briefly explain why you have chosen this set of objects.


X

Activity Identification: Magnet and Compass

Grade(s): 11

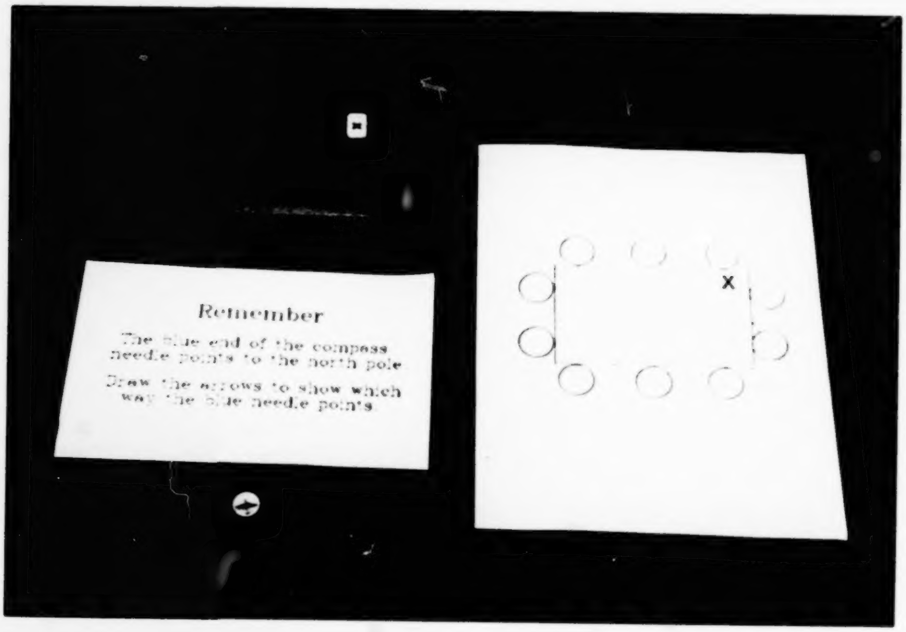
Method of Administration: Self-Administered Station Activity

Content Area: Science-Physics

Apparatus required: Sealed box labelled X containing two bar magnets fixed firmly in position (see diagram below), a compass, a work sheet depicting a rectangular box the same size as box X and ten circles around the perimeter of the rectangle (see attached sheet), paper and pencil.

Administration: Magnets should be stored separately from the compasses to avoid any potential changes in polarity of the compasses. Blue end of arrow indicates north.

Servicing: None required



Remember

The blue end of the compass needle points to the north pole

Draw the arrows to show which way the blue needle points

Magnet and Compass
Station A
Grade 11 - station 6

Scoring of the Written Responses

5) Score 2 pts. if the student checks the appropriate set of objects which is A. Score 1 point if the student makes an inaccurate choice. Score 0 if the student makes no response.

6) Score 2 pts. if the student draws the objects in the appropriate orientation. Score 1 pt. if the student draws the objects in an inappropriate orientation. Score 0 if the student makes no response.

7) Score 2 pts. if the student provides an accurate or plausible reason why she or he chose the set of objects in 5) which should include a reference to the arrows. Score 1 pt. if the student provides an inaccurate or irrelevant explanation for why she or he chose the set of objects in 5). Score 0 if the student gives no response.

Skills involved

In this exercise the student needs to make inferences based on her or his findings and available content knowledge about the problem.

Part 5

ELEVENTH GRADE SCORE POINT 2

5. THE SET OF OBJECTS THAT IS IN BOX X IS:
A X B __ C __ D __ E __ 2

5. THE SET OF OBJECTS THAT IS IN BOX X IS:
[✓ A __] B __ C __ D __ E __ 2

5. THE SET OF OBJECTS THAT IS IN BOX X IS:
A X B __ C __ D __ E __ 2

ELEVENTH GRADE SCORE POINT 1 Part 5

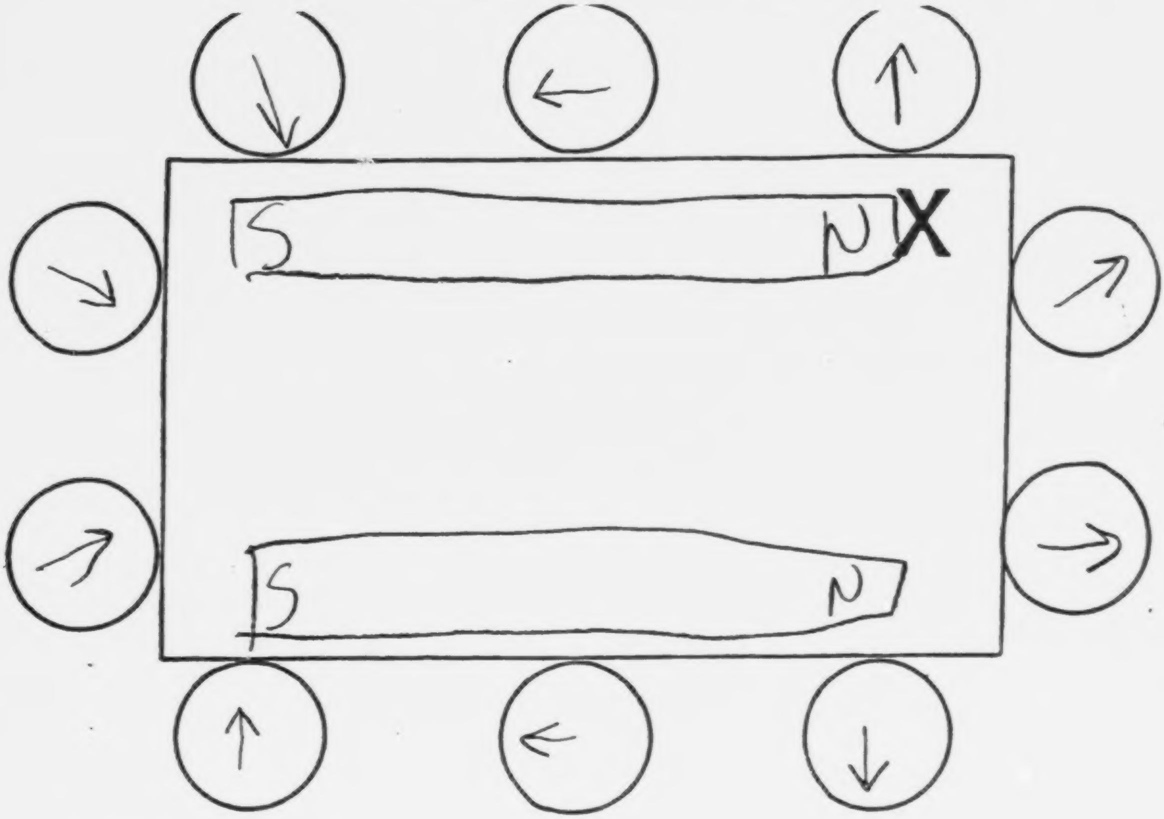
5. THE SET OF OBJECTS THAT IS IN BOX X IS:
A X B __ C __ D X E X ①

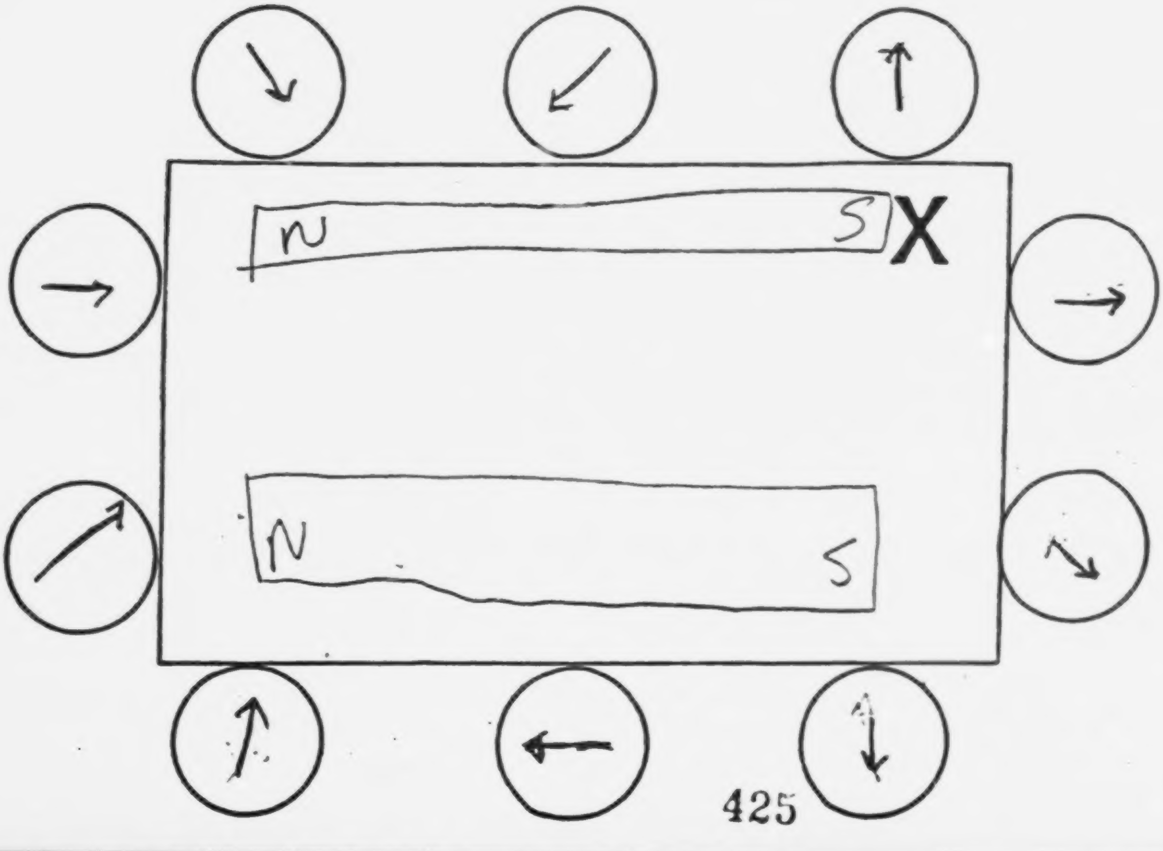
5. THE SET OF OBJECTS THAT IS IN BOX X IS:
A __ B __ C X D __ E __ ①

5. THE SET OF OBJECTS THAT IS IN BOX X IS:
A __ B X C __ D __ E __ ①

Part 6

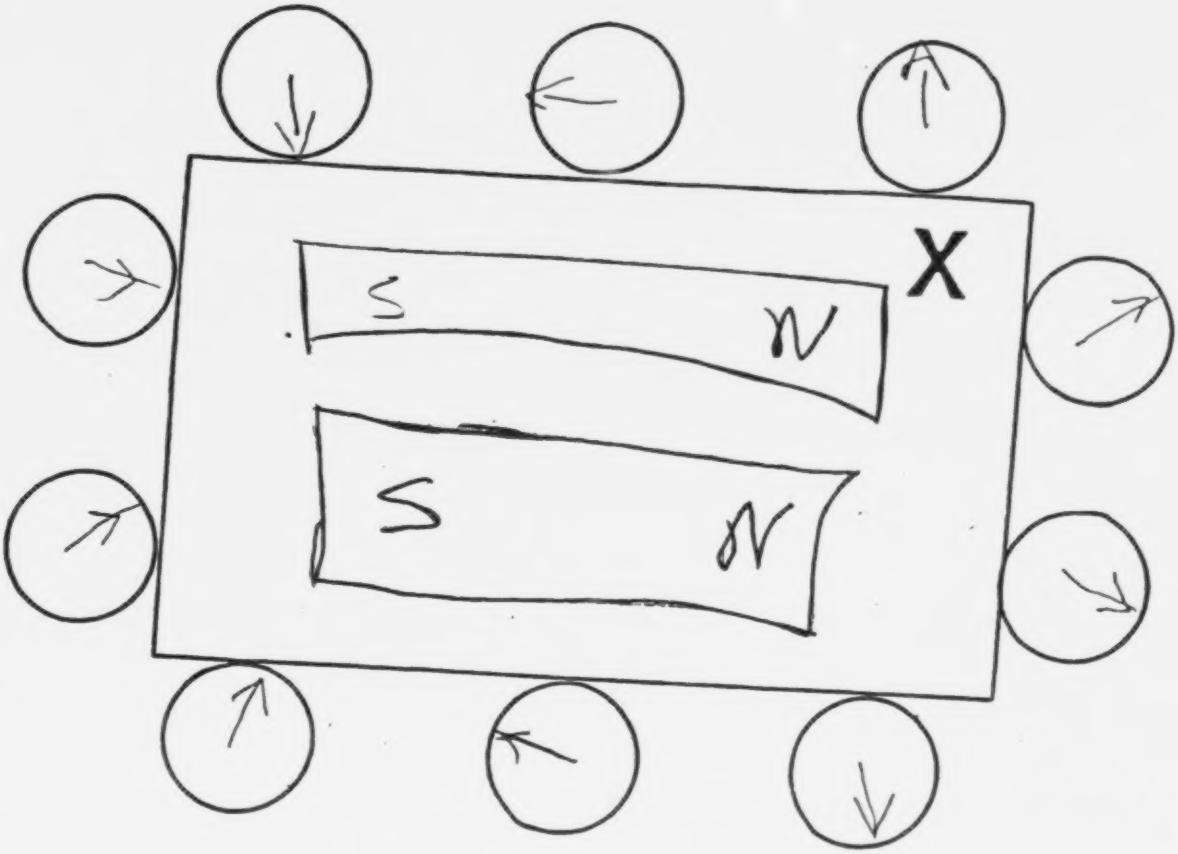
ELEVENTH GRADE SCORE POINT 2



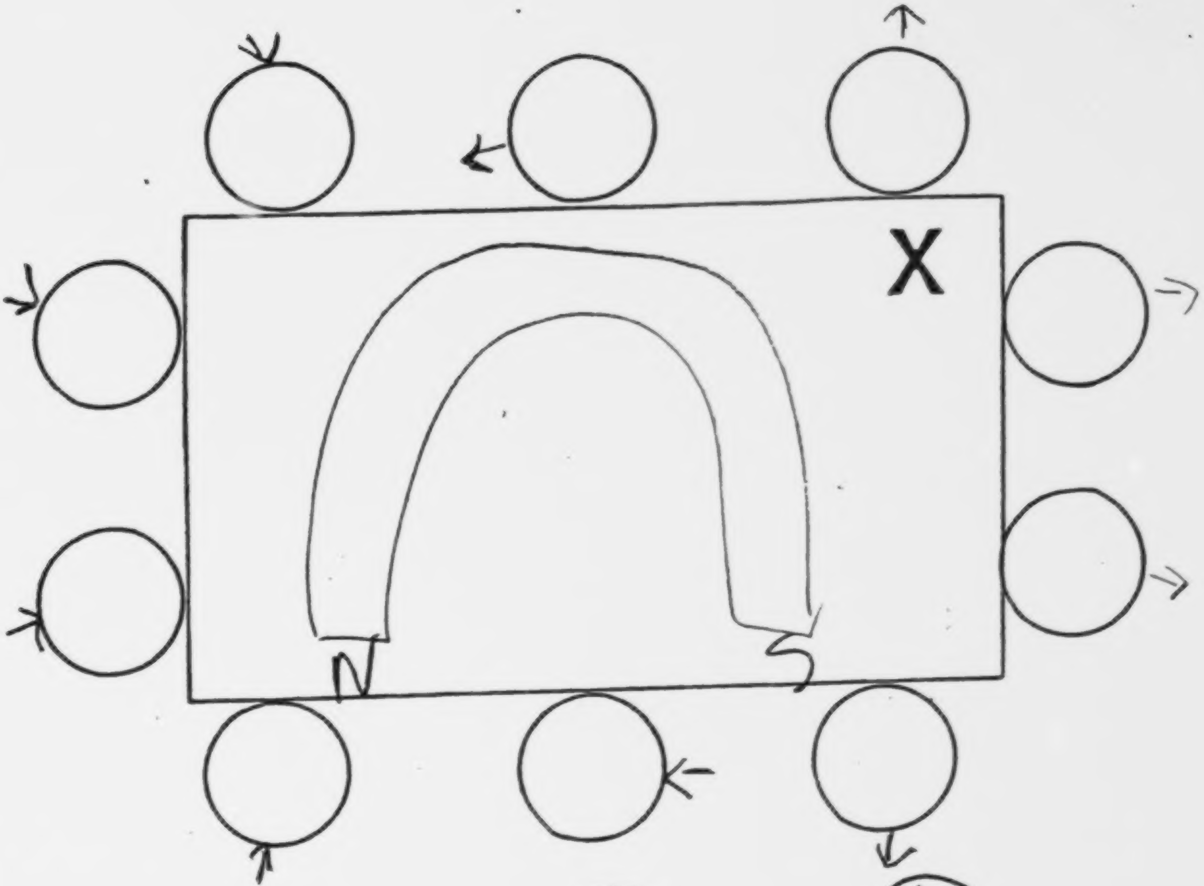


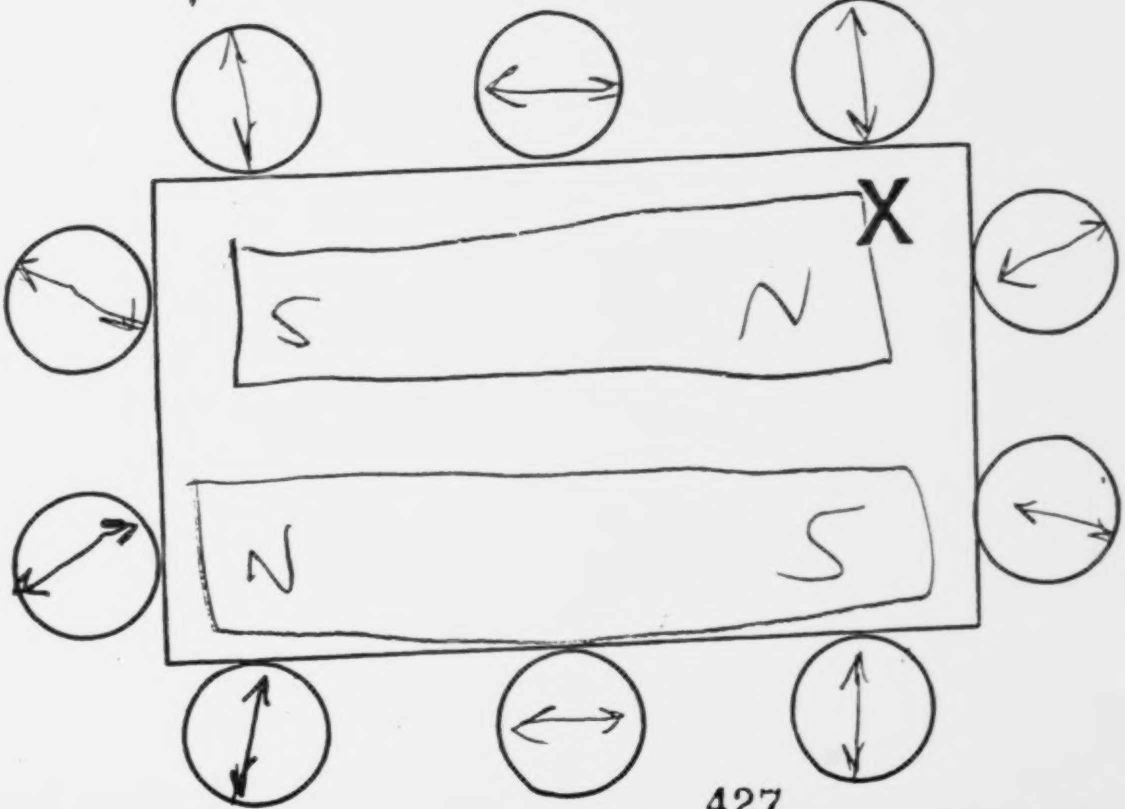
Part 6

ELEVENTH GRADE SCORE POINT 2

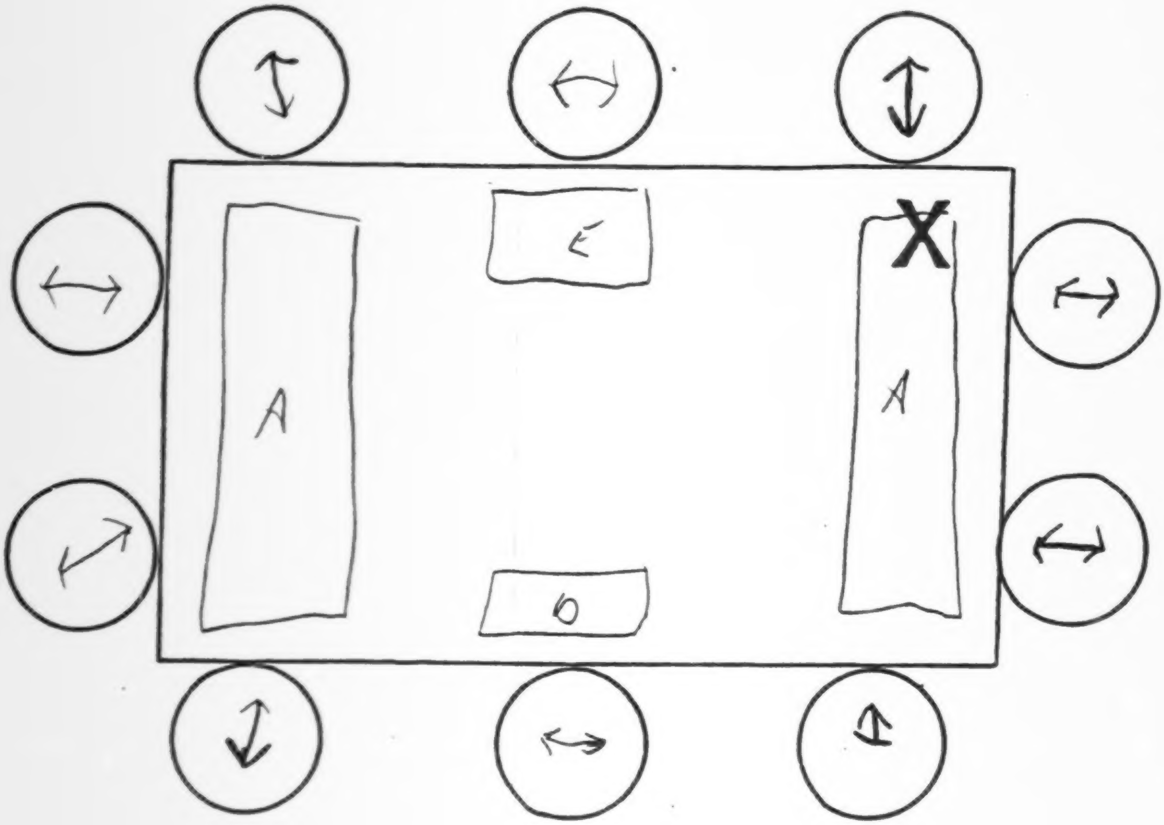


Part 6





Part 6



Part 7

ELEVENTH GRADE SCORE POINT 2

7. BRIEFLY EXPLAIN WHY YOU HAVE CHOSEN THIS SET OF OBJECTS. ②

Because the way the arrows point depicted the force of the magnet ~~dott~~ drawing and pulling the Cumpus arrow

7. BRIEFLY EXPLAIN WHY YOU HAVE CHOSEN THIS SET OF OBJECTS.

opposites attract. I put the north end of the magnet ~~at~~ the end of the box where the arrow pointed away. ②

7. BRIEFLY EXPLAIN WHY YOU HAVE CHOSEN THIS SET OF OBJECTS.

r . The needle is always pointing towards in on the right but away on the left. It must be as shown. The needles in the top & bottom mid section are being fought for by the two poles. so they are parallel to the magnets. ②

ELEVENTH GRADE SCORE POINT 1

Part 7

7. BRIEFLY EXPLAIN WHY YOU HAVE CHOSEN THIS SET OF OBJECTS.

THE CIRCLES IN THE MIDDLE AT THE TOP & BOTTOM REPELL SO. IT HAD TO BE A OR C. A WOULD MAKE THE SIDE ARROWS REPELL BUT THEY WERE ATTRACTED. ①

7. BRIEFLY EXPLAIN WHY YOU HAVE CHOSEN THIS SET OF OBJECTS.

The magnetic arrow point north so it would be pointing away from s and towards N ①

7. BRIEFLY EXPLAIN WHY YOU HAVE CHOSEN THIS SET OF OBJECTS.

The N pts to the left side of the box - therefore I asumed the Magnet must have a nend there. IF ~~[illegible]~~ A was in there the 2 negs & 2 pos would repel eachother ①

Comments on Magnets and Compass (Grade 11)

In this exercise, students were asked to determine the identity of an unknown apparatus. Students had to assess the results of their test and infer whether the unknown was two bar magnets arranged with poles in the same direction, a horseshoe magnet, two bar magnets arranged with poles in opposite directions, an iron bar, or an aluminum bar.

The two bar magnets arranged parallel were correctly selected as the unknown by 39 percent of the students. The most common errors were selection of either the bar magnets arranged antiparallel or the horseshoe magnet. Most of the students who selected the correct unknown also selected the proper orientation of the unknown within the box. About 25 percent of the students correctly explained why they had chosen the correct unknown. The pilot results indicate that more males correctly completed this task than females.

The advisory panel agreed that the exercise was content oriented and that males may have had more previous experience with such equipment. However, they felt the task was appropriate for eleventh graders.

The administrators reported that the students liked "experimenting" with the apparatus. The apparatus is small and, with proper instruction, it is very easy to set up and maintain. This exercise is appropriate for eleventh graders in a future national assessment.

STATION 6

DO SUGAR CUBES DISSOLVE FASTER THAN LOOSE SUGAR? WHAT EFFECT DOES STIRRING THE WATER HAVE?

HERE'S WHAT YOU DO:

FIND OUT WHETHER SUGAR CUBES DISSOLVE FASTER THAN LOOSE SUGAR. YOU MAY USE THE EQUIPMENT IN FRONT OF YOU. EACH PACKAGE CONTAINS THE SAME AMOUNT OF SUGAR AS ONE CUBE.

WHAT DID YOU FIND:

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

____

____

____

____

____

2) FILL IN THE THE BLANK SPACES IN THE SENTENCES BELOW TO SHOW WHAT YOU FOUND.

WHEN THE WATER WAS STIRRED, THE ______________ DISSOLVED FASTER.

WHEN THE WATER WAS NOT STIRRED, THE ______________ DISSOLVED FASTER.

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

____

____

____

Activity Identification: Sugar Cubes

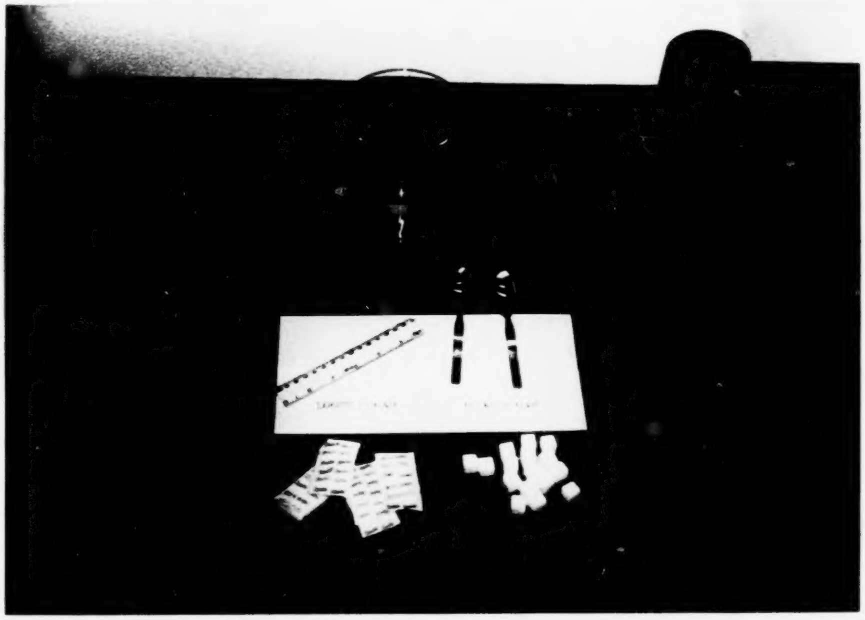
Grade(s): 3,7

Method of Administration: Individually Administered Investigation (3), Self-Administered Activity (7)

Content Area: Science-Chemistry

Apparatus required: Six small glass beakers, sugar cubes in packet, six packages of granulated sugar each containing the same mass of sugar as in one cube; stop clock hot water in thermos

servicing: None required



Sugar Cubes
Station A
Grade 7 - station 6

Scoring of the Written Responses

1) Score 3 pts. if the student notes that the rate of stirring and the amount of water needed to be controlled for in order to compare the dissolving rates of the two types of sugar. Score 2 pts. if the student only notes one of the variables. Therefore the student cites one, but not more than one, of the following: stirring and not stirring, controlling for these two types of trials (stirring and not stirring), the amount of water in each beaker, the rate of dissolving for both types of sugar, or the combination of these sets of variables. Score 1 pt. if the student simply describes what was done (i.e. I stirred the water) or what happened (i.e. They both took time to dissolve). Score 0 if the student makes no response.

2) Score 3 pts. if the student accurately completes both sentences. Loose sugar should be the correct answer for both sentences. Score 2 pts. if the student accurately completes one sentence but not the other. Score 1 pt. if the student inaccurately completes both sentences. Score 0 if the student makes no response.

3) Score 5 pts. if the student provides a plausible reason that is consistent with the responses in 2). Score 4 pts. if the student provides a plausible reason that is inconsistent with the findings in 2). Score 3 pts. if the student provides an erroneous reason but is consistent with the responses in 2). Score 2 pts. if the student provides an erroneous explanation that is inconsistent with the responses in 2). Score 1 pt. if the student provides a description of the findings only. Score 0 if the student makes no response.

Skills involved

In this exercise the student needs to determine how the independent variable affects the dependent variable. This relationship can be determined by making detailed observations involving comparisons and contrasts.

Part 1

SEVENTH GRADE SCORE POINT 3

WHAT DID YOU FIND:

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED. Filled the up to the first line with water.

I took 4 beakers. In 2 I put
cube sugar and in 2 I put loose
sugar I stirred 1 of each until they disolved and
then I recorded my results -

3

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

3

What I did was place equal amounts
of water in two small beakers,
and I then put on packet in
one and one cube in the other.
I Did This twice. Once I stirred it and once I do

Part 1

SEVENTH GRADE SCORE POINT 2

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

I first stirred the water equally by
alternating. Then, when one of the sugars
dissolved, I stopped.

②

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

I added The smame amount of water
in two beakers then I put a sugar cube and
a package of sugar inat the same time and
stirred both of them and the package
of sugar dissolved first.

②

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

②

I put each in 4 separate beakers. I let
two dissolve by themselves, and I stirred
the other two

Part 1

SEVENTH GRADE SCORE POINT 1

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

I put both of them in water at the same time and watched each one

1

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

I filled up two beakers and placed it in

1

1) BRIEFLY DESCRIBE WHAT YOU DID TO COMPARE HOW FAST THE TWO KINDS OF SUGAR DISSOLVED.

I timed the dissolving sugar + stirred them at the same time

1

SEVENTH GRADE SCORE POINT 1

Part 2

2) FILL IN THE THE BLANK SPACES IN THE SENTENCES BELOW TO SHOW WHAT YOU FOUND.

WHEN THE WATER WAS STIRRED, THE sugar DISSOLVED FASTER. ①

WHEN THE WATER WAS NOT STIRRED, THE sugar cube DISSOLVED FASTER.

SEVENTH GRADE SCORE POINT 2

2) FILL IN THE THE BLANK SPACES IN THE SENTENCES BELOW TO SHOW WHAT YOU FOUND.

WHEN THE WATER WAS STIRRED, THE loose sugar DISSOLVED FASTER. ②

WHEN THE WATER WAS NOT STIRRED, THE cube sugar DISSOLVED FASTER.

SEVENTH GRADE SCORE POINT 3

2) FILL IN THE THE BLANK SPACES IN THE SENTENCES BELOW TO SHOW WHAT YOU FOUND.

WHEN THE WATER WAS STIRRED, THE loose Sugar DISSOLVED FASTER. ③

WHEN THE WATER WAS NOT STIRRED, THE loose Sugar DISSOLVED FASTER.

Part 3

SEVENTH GRADE SCORE POINT 5

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS. ⑤'

When loose sugar is stirred its particles break up and separate it dissolves. When its doesn't get stirred they just sit.
With a cube of sugar it dissolves faster when sitting. When stirred it doesn't help

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

loose sugar is already appart ⑤.
So it can dissolve faster

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS. ⑥.

The cubed sugar had to break down before it could dissolve.

Part 3

SEVENTH GRADE SCORE POINT 4

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

4

the loose sugar molecules need to
be spread to dissolve faster in
the cube the molecules were already
somewhat spread apart

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

4

I found when stirred, it goes
a lot faster than sitting . Stirred and
not stirred loose goes faster than cubed because
The sugar has to go off the cubeand
still dissolve.

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

4

Cube sugar has to dissolve froma
cube to loose sugar, so it takes longer.
Loose sugar is already loose so it dissolved
faster. This experiment also depends on the
amount of water.

Part 3

SEVENTH GRADE SCORE POINT 3

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

3

The loose sugar dissolved into the water faster when it was stirred because the sugar was being mixed around and it didn't have time to settle on the bottom. The cube sugar dissolved faster when it was not stirred because then the water tore the cube apart.

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

3

When you stir the loose sugar is loose so it dissolves easie!. When you don't stir the loose. sugar doesn't mix up it just sits and doesn't combine while the cube is breaking apart and dissolving

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

3

The cube took longer because it is more compact.

Part 3

SEVENTH GRADE SCORE POINT 2

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

I found out that packaged sugar dissolves ② faster than cubed sugar because it is not baked into a cube.

SEVENTH GRADE SCORE POINT 1

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

①

When stirred, the loose sugar dissolves quickly, but when set to dissolve by theamselves, the cubes dissolve faster

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

①

The loose sugar dissolves faster when stirred, but the cube sugar dissolves faster when it just sits in water.

EXPLAIN WHAT YOU FOUND:

3) WRITE YOUR EXPLANATION OF THESE RESULTS.

①

I found loose sugar dissolves slower than the cube of sugar untouched and wren stirred, the loose sugar dissolves faster

Comments on Sugar Cubes (Grade 7)

The consultants agreed that the abbreviated version of Sugar Cubes as a station exercise was not appropriate to include in a national assessment. (This recommendation did not apply to Sugar Cubes as a full investigation). The eight minutes allotted for station activities was far too short a period of time for the students to be able to conduct what was potentially a full scale experiment.

STATION 4

WHICH MAGNET IS STRONGER?

HERE ARE TWO WAYS YOU CAN TELL WHICH MAGNET IS STRONGER:

A) TEST TO SEE HOW MUCH EACH MAGNET CAN PICK UP.

B) TEST HOW HARD EACH MAGNET CAN PULL OR PUSH ANOTHER MAGNET.

HERE'S WHAT YOU DO:

1) TEST WHICH MAGNET, A OR B, IS STRONGER.

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO?

____

____

____

Activity Identification: Magnets (strength)

Grade(s): 3

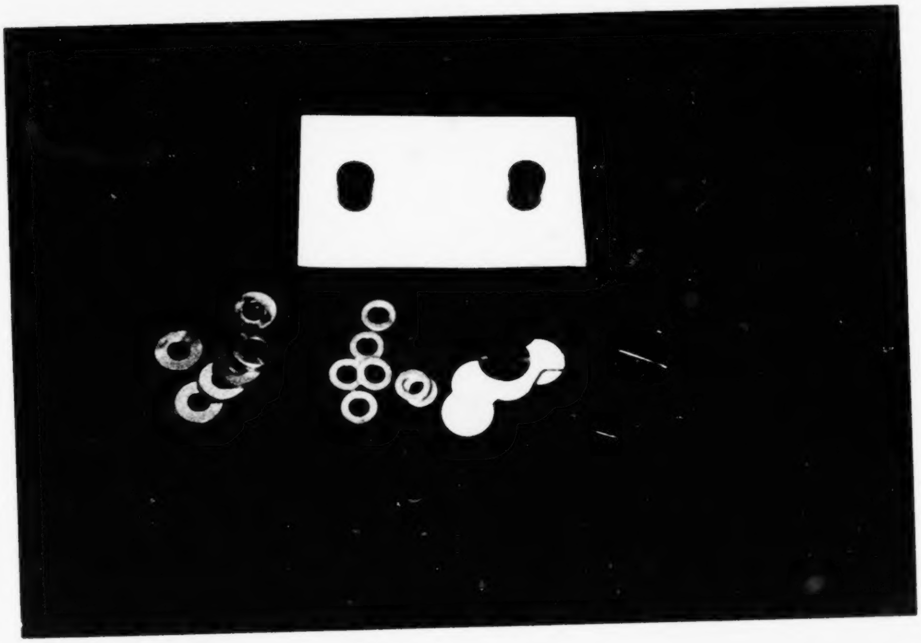
Method of Administration: Self-Administered Station Activity

Content Area: Science-Physics

Apparatus required: Two disk magnets labelled A and B that are comparable in mass, size, shape, and external appearance (strength of magnets should be such that one magnet is 4-5 times stronger than the other one); paper clips; small, round flat markers, plastic buttons, paper and pencil.

Administration: Magnets should be placed a bit away from the other piles of like objects as suggested in the diagram below.

Servicing: None required



Magnets (strength)
Station B
Grade 3 - station 4

Scoring of the Written Responses

2) Score 3 pts. if the student provides one or more plausible reasons why magnet A is stronger than the other. This reason may be based on the instructions in part A).

Score 2 pts. if the student specifies correctly that magnet A is stronger than magnet B without providing a plausible reason.

Score 1 pt. if the student specifies the wrong magnet with or without a reason.

Score 0 if the student makes no response.

Skills involved

In this exercise the student must determine which of two magnets is stronger based on comparing and contrasting the capabilities of each magnet. The student may use her or his own test of magnet strength or use the two methods provided in the instructions. Based on the student's findings, she or he must then infer which is the stronger magnet.

Part 2

THIRD GRADE SCORE POINT 3

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, [✓ A] OR B, IS STRONGER? WHY DO YOU THINK SO?

because A can pick up more than B can.

3.

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO?

A is stronger. Because it picked up more of all the magenets. None of the colored ones picked up on A or B.

3

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO?

I think A is stongest because it could push B and it could also pick more things up

3.

Part 2

THIRD GRADE SCORE POINT 2

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO? 2

A

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO? 2

a is stronger then B

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO? 2

a is because it has more wight
on it

Part 2

THIRD GRADE SCORE POINT 1

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO?

I saw how much They could pick up. 1.

EXPLAIN WHAT YOU FOUND:

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO?

B can not lift much of the big ones 1.
B can allmost lick all the big once up

EXPLAIN WHAT YOU FOUND: They seem the same

2) WHICH MAGNET, A OR B, IS STRONGER? WHY DO YOU THINK SO?

They both feel The same 1.

Comments on Magnets (Grade 3)

In Magnets, students were asked to determine which magnet was stronger. The task seemed appropriate and easy at the third-grade level. The stronger magnet, A, was selected by 82 percent of the students and plausible explanations of "why" were given by 56 percent of the students.

The administrators reported that the students liked working with the magnets. It was the consensus of the advisory panel that the exercise was too simplistic as presented. It was suggested that it be made more challenging by the following revision, "Which magnet is stronger, A or B? Why do you think so?" This would allow students to design their own testing methodology.

Because the second method is not useful in determining which magnet is stronger, another suggestion was to assess the two methods separately and revise the questions as follows:

What is your result using Method A?

What is your result using Method B? or

What did you find out using Method A? etc.

The revised exercise could be used at all grades. The materials are small and very easy to set up and maintain. This exercise could be appropriate for any future national assessment if a commercial source for the magnets is found and if it is revised and pilot tested.

CHAPTER 3

FULL INVESTIGATIONS
BACKGROUND
FORMAT OF THE FULL INVESTIGATIONS
ANALYSES

Activity Identification	Grade(s)
Sugar Cubes	3
Pegboards	3, 7, 11
Density	7, 11
Survival	7, 11

Background

These exercises require students to design and conduct an experiment investigating a problem posed by an administrator. As the student works on the problem, the administrator is responsible for recording the student's behaviors on a checklist. Immediately following the investigation, the student is asked questions concerning the experiment. The students' oral responses also are recorded by the administrator. In these exercises, the purpose for collecting information about the student's behaviors and oral responses is to gain an understanding of how students apply higher-order thinking to their investigation of perceived scientific concepts in an experimental setting.

The full investigation exercises are unique because they offer students an opportunity to independently devise and structure their own framework of problem-solving rather than respond to one already presented in a given exercise (as is the case in the group and station exercises). More importantly, in order to devise and implement this "personalized" approach, students are called upon to use the full range of the aspects of higher order thinking as specified in the model of the higher-order skills framework.

Three of the four full investigations, Sugar Cubes (Grade 3), Pegboards (Grades 3, 7, and 11), and Survival (Grades 7 and 11) were adapted from full investigations developed by the APU science monitoring project. Modifications were made to these exercises in accordance with the APU recommendations for use in the NAEP pilot test and included an abbreviated checklist of behavior and a single column to record the behaviors for one trial of experimentation (the APU had used multi-column checklists to better record the student's behavior across several trials). These revisions enabled NAEP to administer the full investigations given the limited number of administrators and time available to train them. However, the manner in which the full investigation problems were presented to the students was comparable to that used by the APU for their sample except for those issues mentioned earlier in Part I of the report.

The fourth full investigation, Density (Grades 7 and 11), was developed by NAEP.

Format of the Full Investigations

All full investigations were comprised of a script, a behavioral checklist, and a student response sheet. The scripts were read by the administrator to the student and provided an introduction to the problem and the task. All scripts were the same for all students within a given exercise.

The behavioral checklists were filled in by the administrator as the student worked on the problem. Because single column checklists were provided, the administrator was to simply check whether a behavior did or did not occur during the student's work regardless of how many times the student might have stopped and started over again. All checklists were divided into sections which contained behaviors that were appropriate to the type of problem set (e.g. problems concerned with single variable relationships).

These behaviors included those which were related to the independent variable and how it is varied (e.g. stirring or not stirring trials in Sugar Cubes); manner of measurement of the dependent variable and associated techniques (i.e. timing the number of swings in Pegboards); and methodological awareness (i.e. acknowledgement that aspects of the experiment could be improved in all investigations). The checklist for Density differed from this format slightly in that sections were divided on the basis of type of measurement and method of computing density. The methodological awareness section was still included. The purpose for dividing the checklists into sections was to facilitate the administrators' task in filling them in, to help identify the student's behavior on certain aspects of the problem, and for purposes of analysis. For example, the student's pattern of behavior within the independent variable section might indicate how well the student understood the problem and which variables needed to be manipulated in order to reach a conclusion.

The third aspect of the full investigation exercises consisted of a student response sheet which the student used as a space to record her or his findings. These sheets also included space for notes the student wanted to make during work. For all the investigations, the response sheets were used as a check on a student's work rather than an index of how well the student reached a conclusion to the problem.

Analyses

Frequency Counts

For all full investigation exercises, frequency counts were computed for each of the behavioral checklist points. These counts only included the occurrences of a given behavior. Non-occurrences were not tabulated. Frequency counts also were computed for scores assigned to answers on the student response sheets.

The analyses in this project were limited to frequency counts because of the small sample sizes. However, if full investigations are used in a national assessment more conclusive analyses should be conducted to discrimate among levels of student performance.

A note of caution should be added that the frequency counts for some of the data may be either inflated or deflated because of administrator inconsistencies in completing the checklists.

Comments on Sugar Cubes (Grade 3)

In the Sugar Cubes full investigation, students were asked to determine which type of sugar, loose or cubed, would dissolve faster in water when the water was stirred and not stirred. Therefore, the independent variables in this investigation were type of sugar; loose or cubed and stirring the water and not stirring the water. The dependent variable was the rate at which the sugar dissolved. The loose sugar dissolved faster under both sets of conditions.

Review of the Frequency Data

Review of the data from the students' response sheets indicates that the task was appropriate for third-grade students. Eighty-two percent identified loose sugar as dissolving faster than the cube sugar and about 21 percent accounted for how stirring affected the difference in rate between the two sugars.

For those students who conducted either a set of stirring or non-stirring trials, a large percentage of the students tested both types of sugar. For example, for the not stirring trials, about 56 percent tested the loose sugar and 73 percent tested the cube sugar. Similarly, for the stirring trials, 80 percent tested the loose sugar and 94 percent tested the cube sugar. Apparently, there is substantial overlap between students who tested both types of sugar for each set of stirring and not stirring trials. A smaller percentage of students demonstrated conservation of the mass of sugar and volume of the water for each of the trials. For example, for the not stirring trials, 30 percent of the students controlled for the volume of the water used to test the sugar and about 51 percent controlled for the mass of sugar tested. Similarly, for the stirring trials, 46 percent of the students controlled for the volume of water and 70 percent controlled for the mass of the sugar. A review of the student's use of the apparatus such as the graduated cylinder indicated that 6 percent of the students used the cylinder to measure water for the not-stirring trials and 4 percent of the students used the cylinder for the stirring trials. By comparison, 49 percent of the students measured the water by eye for the not-stirring trials and 72 percent of the students measured the water by eye for the stirring trials.

An indication of how reliably students measured the dependent variable might be indexed by how many students made qualitative measurements and/or no apparent measurements. A review of the frequency counts indicates that for the not stirring trials, 8 percent of the students made no apparent measurements and 42 percent made qualitative measurements. For the stirring trials, 13 percent of the students made no apparent measurements and 66 percent made qualitative measurements. These counts suggest that these younger students tended to rely upon qualitative measurements more so than objective measurements.

Recommendations for Future Use

The Advisory Panel agreed, after reviewing the preliminary data, that Sugar Cubes would be an appropriate exercise for third grade students in an assessment situation. It appeared that these students took measurements and conducted an investigation. A closer look at the data, however, indicates that third grade students may have had difficulty determining which were the independent and dependent variables and how best to test them. Given this difficulty, a recommendation for future use of this exericse among a third grade population would be to include a smaller scale study where students are asked to work with a single independent variable. The Advisory Panel also suggested that the checklist be restructured so that the order in which behaviors were demonstrated could be recorded, and also to include some summary statements which would note whether a student tested both types of sugar for a given trial. The Panel noted that the questions on the response sheet should be worded more clearly so that students better understand what sort of answer is required.

A final recommendation would be to include more extensive training of the administrators on this exercise so that they would be better able to observe students' behavior and fill in the checklists more efficiently.

Comments on Pegboards (Grades 3, 7, and 11)

In the Pegboards full investigation, students were given a set of nine different boards of three different lengths and three different widths and asked to determine whether length or width would affect how fast the board swings. Therefore, the independent variables were length and width and the dependent variable was the rate at which a given board would swing. For this particular investigation, length was the key variable with shorter boards swinging faster than longer boards. Width had a very small effect on the rate of swing.

Review of the Frequency Data

A review of the frequency data for the students' response sheets indicated that students in third, seventh, and eleventh grade were aware that length varied directly with the period of the swing. These percentages were 37 percent, 63 percent and 61 percent for the third-, seventh-, and eleventh-grade students, respectively. Very few students cited that width also made a difference (4 percent for the third graders, 9 percent for the seventh graders, and 27 percent for the eleventh graders) which suggests that they were concerned with main effects only.

A survey of the checklist frequency indicated that 82 percent of the third-grade students, 84 percent of the seventh-grade students, and 93 percent of the eleventh-grade students conducted a test of length. For the test of width, the percentages at the older grade levels were comparable. However, many third-grade student do test both variables. Therefore seventh- and eleventh-grade students were successful on this aspect. However, fewer third-grade students (68 percent) conducted a width test. This may indicate a difficulty some younger students have in dealing with more than one independent variable as indicated in the discussion of Sugar Cubes.

The frequency counts pertaining to the measure of the dependent variable indicated that some students timed between 1 and 10 swings. These percentages were 6 percent for the third graders, 20 percent for the seventh graders, and 31 percent for the eleventh graders. Both these sets of percentages show that across all grades, many students may not have appropriately conceptualized the dependent variable. However, 65 percent of the third grade, 71 percent of the seventh grade, and 74 percent of the eleventh grade students did measure the dependent variable by making comparisons between two boards. Most of these comparisons appear to have been made by eye, rather than using a clock to time the rate; 82 percent at the third-grade, 73 percent at the seventh-grade, and 81 percent at the eleventh-grade.

Some students chose to time the boards until the end of the movement, thus failing to derive rate by considering both variables; time and oscillation. These percentages were 16 percent, 15 percent, and 14 percent for the third-, seventh-, and eleventh-grade students, respectively.

Recommendations For Future Use

The Advisory Panel agreed that Pegboards was a difficult exercise to administer to students within a national assessment and recommended that it not be used.

Comments on Density (Grades 7 and 11)

The Density task differs from the other full investigations in that it does not involve the need to control variables. Rather, its interest lies in how the students go about solving the problem, which can be approached in a variety of ways. For example, some students may recognize that the solution involves the density of the materials and may know how to compute density. Others can work out the answers in a variety of other ways such as using the weights of the blocks and the volumes of the blocks and box, or by using weights and estimations with or without measurement of the blocks and/or box.

Review of the Frequency Data

Because there were inconsistencies in the line by line records on the checklists, the students' work on the response sheets and the accompanying checklists were reviewed holistically and the responses classified into five types of approaches. (See Note on following page.) The score levels for each group were tallied. The data indicate that there was very little difference between the percentage of seventh and eleventh grade students who provided the correct answers. However, the results of the classification suggest differences between the grades in the approach to solving this problem although the total number of correct responses at the two grade level was identical. In grade 11, the direct computation of density was most used and also produced the most scores of 3 (both heaviest and lightest correctly determined). In grade 7, the most often used approach (other than the variety of approaches in other) was simple estimation, but systematic estimation produced the most scores of 3.

There was little evidence of checking of work through repeated measurement. However, some students did some reweighing (7 at grade 7, and 9 at grade 11) and a few students noted weights in both grams and ounces and/or measurements in both centimeters and inches.

Recommendations for Future Use

This task may be more appropriate for grade 7 if the assessment of creative thinking is the goal because students at this grade need to devise their own method to solve the problem. Some 11th graders may have a learned algorithm to apply if they recognize its appropriateness. Apparently the task is feasible for both grades and could be used in a national assessment. It was suggested that, if it is reused, the blocks be manufactured and made smaller with somewhat greater differences in density.

Note: The five types of approaches were defined as follows:

A. Density: all cases using a formal density approach, whether formulas and/or computations were correct or not.

B. Volumes: All cases in which volumes of the blocks and of the box were computed, whether formulas and/or computations were correct or not.

C. Systematic Estimation: all cases in which the number of blocks to fill box was estimated but estimation was preceded by measurement of the blocks and/or the box or where there is clear evidence of planned procedure.

D. Simple Estimation: all cases in which the blocks were weighed and then estimation with no intermediate measurement except, in a few cases, just the width of the box or blocks.

E. Other: all other cases including no apparent strategy, meaningless strategy, answer based on block weights only, combinations of methods.

Comments on Survival (Grades 7 and 11)

In the Survival full investigation, students were given two types of material; blanket and bubble plastic, and equipment that could be used (see actual exercise for specifications of equipment) to determine which type of material would keep them warmer in cold, dry weather. Therefore, the independent variables were type of material; blanket and bubble plastic and the dependent variable was thermal conduction judged by the amount of heat transfer blocked by each material. For this particular investigation, the bubble plastic was a better insulator than the blanket.

Review of the Frequency Data

A review of the frequency data for the students' response sheets indicated that 49 percent of the seventh graders and 61 percent of the eleventh graders determined that the bubble plastic would keep them warmer. The data from the frequency counts indicated that 93 percent of the seventh graders tested the blanket material and 89 percent tested the bubble plastic material. For the eleventh graders, 93 percent tested the blanket and 95 percent tested the bubble plastic material. Therefore, on a single discontinuous independent variable, performance was high. (These results are comparable to APU findings).

A review of some of the behaviors pertaining to the students' set up of the investigation indicated that 67 percent of the seventh-grade students wrapped the blanket material around cans A or B which are same-sized metal cans and 61 percent did the same for the plastic material. Similarly, 81 percent of the eleventh graders wrapped the blanket material around cans A or B and 74 percent did the same for the plastic material. These findings suggest that the seventh- and eleventh-grade students understood the testing of the materials well enough to test them under comparable conditions, such as wrapping them around a metal can of the same size. (This finding can be compared with performances on Pegboards which also indicate that students do control variables whose effects are known). Many of the students in both grades also seemed to understand that hot water, rather than warm or cold, should be placed in the cans so that retention of heat could be measured. For example, 76 percent of the seventh graders used hot water for testing the blanket material and 70 percent used hot water for testing the plastic. For the eleventh graders, 65 percent used hot water for the blanket material and 61 percent for the plastic.

A review of the frequency count data for the behaviors related to measurement of the dependent variable indicated that 35 percent of the seventh graders took baseline readings of the temperature for the blanket and plastic materials. For the eleventh graders, this percentage was 65 percent. A much smaller percentage of the students for each grade took three or more readings of the temperature during their investigation. For example, 13 percent of the seventh graders took three or more readings for the blanket test and 11 percent for the plastic test. For the eleventh graders, 39 percent (triple the percent at Grade 7) took three or more readings for both the blanket test and the plastic test. Fewer seventh-grade students made final readings than eleventh-grade students. For example, 35 percent of the seventh-grade students made final readings for the blanket and plastic test. For the eleventh graders, the percentage for both tests was 60 percent. Thus, from the findings presented above it would appear that fewer seventh-grade students than eleventh-grade students saw the solution to the problem as a comparison of cooling curves. Many of students seemed to consider a simple comparison of before and after as an appropriate solution. However, both seventh- and eleventh-grade students did show similar performance on manipulation of the independent and control variables.

Recommendations for Future Use

The Advisory Panel agreed that Survival would be an appropriate exercixe for Grades 7 and 11 in a national assessment.

NAME ________________________

SCHOOL DISTRICT ____________________

CODE ________________________

FIND OUT IF SUGAR CUBES DISSOLVE FASTER THAN LOOSE SUGAR.

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

FIND OUT IF STIRRING MAKES ANY DIFFERENCE TO HOW FAST THE SUGAR CUBES AND LOOSE SUGAR DISSOLVE.

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

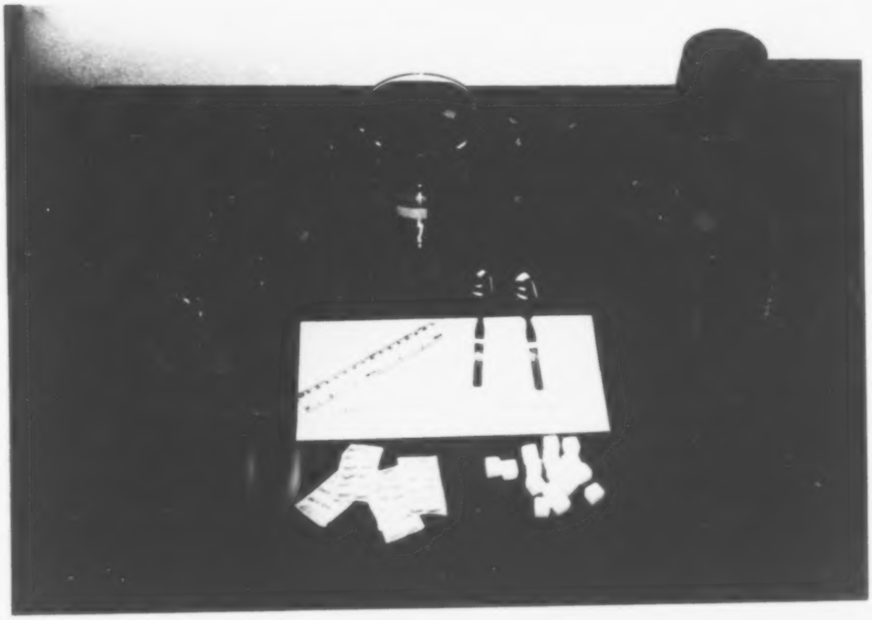
Activity Identification: Sugar Cubes

Grade(s): 3, 7

Method of Administration: Individually Administered Investigation (3), Self-Administered Station Activity (7)

Content Area: Science-Chemistry

Apparatus required: Six small glass beakers, sugar cubes in packet; six packages of granulated sugar each containing the same mass of sugar as in one cube; hot water in thermos (50°C-60°C); two stirrers, graduated beaker, measuring cup, small ruler, paper and pencil.



Individually Administered Investigation- 3
Instructions for the Administrator

Show the student the sugar cubes and the packets of sugar.

For this question you will be dissolving sugar in water. In each of these packets is the same amount of sugar as there is in one cube of sugar.

Pour one packet of sugar into a beaker. Pour some hot water in (about half-full) and offer student a stirrer to stir the water.

Look what's happening to the sugar. What would you say is happening?

Accept whatever description the student gives- "disappearing", "melting" or something comparable. If the student does not use the word "dissolving" say:

The word to describe what is happening to the sugar is "dissolving"-do you know that word?

If the student says "no" repeat slowly "dissolving- that is what is happening to the sugar".

We are using warm water because sugar dissolves faster in warm water than in cold water.

I wonder if sugar cubes and packets of sugar dissolve in the same length of time. And I wonder if stirring makes any difference? These are the things you can find out using the equipment here (A should point to each object as it is mentioned). You have several packets of sugar, all with the same amount of sugar as in one cube. There are some more beakers and one which can be used to measure water. There are two stirrers, a stopwatch, a ruler and some paper to label things if you want to. Let me just show you how to use to stop watch (A should demonstrate). **Press this button to start the timer** (A should press the start button). **Press this button to stop the timer** (A should press that same button if the stopwatch is the Armitron used in training. The instructions may need to be adapted if another type of stop watch is used.) **You don't need to worry about this middle button which isn't part of the timer. Why don't you play with this for a little while so you can make sure that you know how to use it.** (A should let the student play with the stopwatch until it appears obvious that the student knows how to use it. If the student spends too much time playing with the stopwatch, demonstrate its use one more time and then move on.) **You don't have to use all these things, just use what you want.**

Turn to the student's response sheet and read out the part in the box, pointing to each word so he can see it.

Now let's look at your sheet. Here it says what you are finding out. Let's look at A. Find out if the sugar cubes dissolve more quickly than packets of loose sugar. Now lets look at B. Find out if stirring makes any difference to how fast the sugar cubes and the loose sugar dissolve. Now there is a space here at A) for you to write down any notes as you go along. There isn't time to write down everything you do, so just write notes to help you remember what you did and what you found. Then write down the answer to the question. Then at B) there is another space for you to take some notes and answer the question in the box. Do you understand what you have to do?

Answer questions about what the problem is; questions about how to tackle it should be addressed by something like:

You think about that and try to decide what is the best way to do it.

Then ask:

Now before you start, just to make sure that I have explained things properly, will you tell me what it is that you are going to find out? Not how you are going to do it, but what you understand the question to be.

Give time for the student to explain in his own words. If the student has grasped the problem, tell him to go ahead. If the student has not grasped the problem, go over the parts which have been misunderstood. When you are satisfied that the student understands the problem, tell the student: **Remember, you will have about 20 minutes to work on this investigation which should be plenty of time.** The student should then be told to start work.

Observations during activity

The A should note whether the student takes any notes, however minimal. All students should be told that if they need more room to take notes, or write answers to their questions that they should use the back of their sheet. You need not remind the student to take notes.

When the student appears to have finished and has not written anything for a 4 minute period of time, wait to be sure the student is finished and the A then asks: **Have you finished?**

If the student says "yes", the A says: **Remember you have to put down what you found on your paper.**

Follow-up questions to be asked after the investigation

(You may want to use the information obtained here to help you fill in the checklist)

The A looks at the student's paper and asks: **May I see what you have found?**

The A should note whether the findings that the student reports are the same as what the student has done. The A should then ask: **If you could do this experiment again, using the same things that you have here would you do it in the same way or change some things that you did to make the experiment better?**

The A should give the student plenty of time to answer. If the student answers "the same way", the A should confirm this by asking: Would there be anything you would change? If the student says that she or he would make changes, the A should ask what these changes are and confirm that they are considered to be improvements by asking why these changes would be better than what was done before.

The A should evaluate the student's responses for a critical view of what has been done rather than the relative utility of the changes specified.

NAME: ______________________________
CODE: ______________________________
SCHOOL DISTRICT: ____________________

Sugar Cubes Behavioral Checklist

NOT STIRRING (iv)

1. Loose sugar tested ☐
2. Cube sugar tested ☐

SET-UP (cv)

3. Volume of water measured - by eye ☐
    4. by ruler ☐
    5. by cylinder ☐
6. Volume used < 10 cc ☐
    7. Volume used > 10 cc ☐
8. Volume same for both types ☐
9. Mass same for both types ☐

MEASUREMENT (dv)

10. No apparent measurement ☐
11. Qualitative measurement ☐
12. Clock used ☐
    13. within +- 3 secs. of start point ☐
    14. within +- 3 secs. of end point ☐
15. Timed - until all dissolved ☐
    16. until partially dissolved ☐
    17. no clear end point ☐
18. Fixed time - notes amount remaining ☐

RESPONSE SHEET

*19. Reports results consistent with evidence ☐

STIRRING (iv)

20. Stirring not tested - sugar type not controlled ☐
21. Loose sugar tested ☐
22. Cube sugar tested ☐
23. Stirring tested - by counting number of stirs ☐
    24. by timing ☐
25. Stirring at regular intervals ☐
26. Stirring rate - constant ☐
    27. random ☐

SET-UP (cv)

28. Volume of water measured - by eye ☐
    29. by ruler ☐
    30. by cylinder ☐
31. Volume used < 10 cc ☐
    32. Volume used > 10 cc ☐
33. Volume same for both types ☐
34. Mass same for both types ☐

MEASUREMENT (dv)

35. No apparent measurement ☐
36. Qualitative measurement ☐
37. Clock used ☐
    38. within +- 3 secs. of start point ☐
    39. within +- 3 secs. of end point ☐
40. Timed - until all dissolved ☐
    41. until partially dissolved ☐
    42. no clear end point ☐
43. Fixed time - notes amount remaining ☐

RESPONSE SHEET

*44. Reports results consistent with evidence ☐

EVALUATION OF WORK

45. Uses same water for both trials ☐
*46. Repeats trials to check findings ☐
47. Makes notes (however minimal) ☐
*48. Acknowledges that procedures could be improved if experiment repeated - aware that certain variables could be controlled ☐

Check off all those which apply:

Scale of experiment ☐
(i.e. would need more apparatus; not enough time to experiment)
Rate of stirring ☐
Use of volume ☐
Type of sugar tested ☐
Volume of water used ☐
Timing interval used ☐
Other ______________________________ ☐
(please specify)

Scoring of the Response Sheets

Sugar Cubes
Grade 3

A) Score 2 pts. for correct answer of **loose sugar.** Score 1 pt. for an incorrect answer (i.e. **cube**). Score 0 for no response.

B) Score 5 pts. for a response which states that both types of sugar dissolve faster but the loose sugar still dissolves the fastest. Score 4 pts. for a responses which states that the loose sugar dissolves faster than the cube and that stirring or not stirring is the cause of it (i.e. Stirring makes a big difference. The loose sugar dissolved much faster.). Score 3 pts. if the student states that stirring does or doesn't make a difference only (i.e. It doesn't) or how or why an effect upon the sugar is found only(i.e. The stirring makes the sugar fall apart). Score 2 pts. if the student states that one type of for sugar dissolves faster than another only. Score 1 pt. for an incorrect response. Score 0 for no response.

Part a

THIRD GRADE SCORE POINT 2

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

The loose sugar disolved faster. I think because the loose sugar isn't packed tight like the cubes. ②

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

The Loose sugar Dissolves faster than the Sugar in the cube. ②

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

The loose sugar dissolve faster than the cubes. ②

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

I think the sugar cube dissolves faster than the loose sugar. ①

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

It looks like the cube is dissolving much faster then the loose sugar. ①

A) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

The sugar cube dissolve faster becaues it got to work and the loose sugar just sat there. ①

Part B

THIRD GRADE SCORE POINT 5

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

⑤

It makes a diffrence when you stir the Loose suger cause it dissappers faster than the cubes so if you stir the cubes they will make a tiny diffrence.

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

⑤

The sugar cubes dissolve fast when they are stired when the loose sugar is stired it dissolves even faster than it dissolved before.

Part B

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

Stirring makes a big difference. The Loose sugar dissolved
MUCH faster. I guess it just was "picked up" from the
bottom & dissolved on the surface.

④

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

Stirring makes the loose
sugar dissolve faster.
But the cubes dissolve slower.

④

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

When you mix loose sugar it is
easyer, because you really dont have
to mix it because it's not like sugar
cubes are in squarse and you have to
mix it to get it broke up in to pices.

④

Part B

THIRD GRADE SCORE POINT 3

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

I think stirring makes it disolve faster cause the spining around makes the pieces fall of and then it would disolve.

③

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

I think that stirring helps dissolving because it faster contact with the water.

③

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

I think stirring makes it dessolve faster. Beasuce when the spoon hit's the sugar it seperates, that makes it go ~~up~~ faster.

③

In cold water it takes longer to desolve,

Part B

THIRD GRADE SCORE POINT 2

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

the cubes dissolve faster when stirring. ②

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX. ②

It helps the cube to dissolve faster but not the loose sugar.

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

The sugar cube takes longer to Dissolve than befor. ②

Part B

THIRD GRADE SCORE POINT 1

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

yes.

①

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

It will make the suger and
it will make little spots on
the the bottom of the glass.

①

B) USE THE SPACE BELOW TO ANSWER THE QUESTION IN THE BOX.

When you stiny the Cube sugar it just
go brack up in pieces
2.minuts and 19 seconds

①

GRADE 3,7,11

NAME ____________________

SCHOOL DISTRICT ____________________

CODE ____________________

HOW DOES THE LENGTH OF THE BOARD CHANGE HOW FAST IT SWINGS?
HOW DOES THE WIDTH OF THE BOARD CHANGE HOW FAST IT SWINGS?

A) USE THIS SPACE TO MAKE ANY NOTES.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

____

____

____

____

____

____

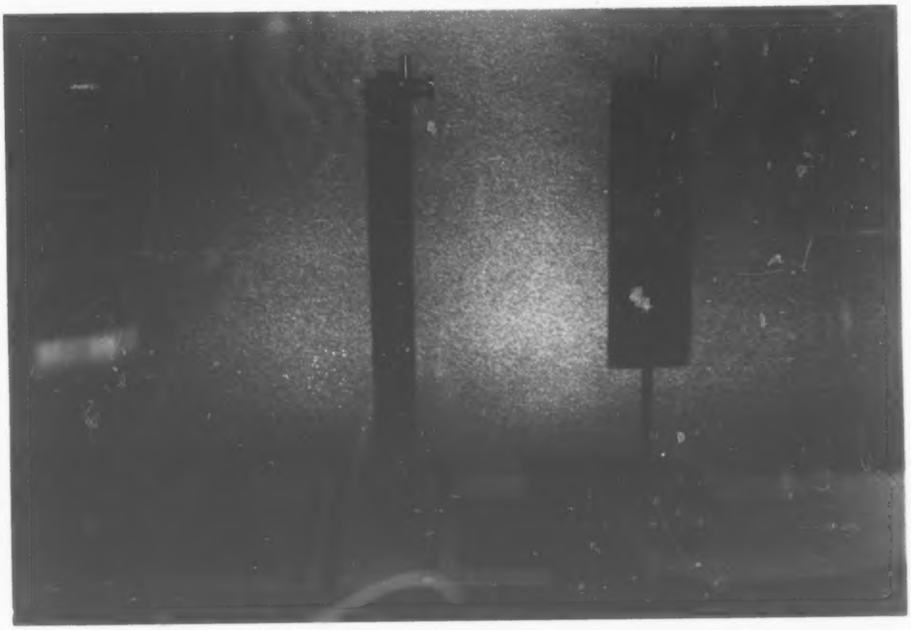
Activity Identification: Pegboards

Grade(s): 3,7,11

Method of Administration: Individually Administered Investigation

Content Area: Mathematics-Geometry/Science-Physics

Apparatus required: Nine pegboards of three different lengths and three different widths, stop clock, 12-inch ruler, two ring stands, two clamps, two rods and hooks (picture attached).



Full Investigation - 9

Instructions for the Administrator to read to the student: A has the middle length/middle width board hanging on the left hand stand and the short/wide board hanging on the right hand stand before the student starts. Both should be hanging from the same hole (middle one on top row).

A gives the student the response sheet and says: I **have a problem for you about these boards in front of you. Watch what happens when I start them swinging.**

The A should start the boards swinging, one after the other, casually, without any attempt to make the amplitudes the same.

The A should say: **Do they swing just as quickly as each other or is one swinging faster?** The A should make sure that the student identifies which is swinging more quickly. The A should stop the boards swinging and look at them.

The A then says: **What do you notice about the length and width of these boards?**

The A should let the student say which is longer and which is wider.

The A then says: **Yes, they are different in length and in width, aren't they? This might be making a difference to how fast they swing. In a minute you are going to use these things for an experiment, so you have a good look at them. You can take the boards off like this** (A should demonstrate) **and move the books up or down if you like** (A should demonstrate). **You try doing that and make the boards swing.**

The A should allow 2 or 3 minutes for the student to play with the boards and stands. When the student has finished put the two boards with the other ones laid out in three piles by length.

The A then says: **Now there's something about these boards that I want you to try to find out. See if changing the length makes any difference to how fast the board swings and see if changing the width makes any difference to how fast it swings. You can use any of these boards- these wide ones, these middle sized ones and these narrow ones** (the A should point to each pile). **There also is a ruler and a stop clock for you to use if you think it will help you answer the questions. This is how you can use the stop clock** (A demonstrates how to start, stop, and reset the watch). **Now you try it** (A lets the student try using the stop clock).

The A the says: **Before we begin, let's read together what it says on your sheet and make sure you understand what you have to do here.** A reads the information printed in the box on the response sheet aloud to the student **How does the length of the board change how fast it swings? How does the width of the board change how fast it swings? Here is a space** (A points to A on the response shet) **where you can write down what you find out as you go along. When you think you know the answers to the two questions** (A points to the questions on the student's response sheet) **write them down in the spaces that are given at B). Do you have any questions?** (A should wait to answer any of the student's questions about how to use the equipment or about the task).

The A then says: **Now before you start, just to make sure I have explained everything clearly, you tell me what you are going to find out.**

The A should note the way that the student formulates the investigation. If the student has put it in terms of a procedure, the A should say: **Tell me what you understand the problem to be, not what you are going to do.**

When the A is satisfied that the student has grasped the problem, the A should say: **You will have 20 minutes to work on this investigation which should be plenty of time. Okay, let's go ahead.**

Observations during activity

During the activity, the A should not interrupt the student. If the student asks a question, the appropriate reply should be: **You decide how to do it** or **You can use anything in any way that you want**, etc.

The A should watch the actions carefully and note the results as far as possible on her or his own. The checklist should be used to keep track of which boards are used and the sequence in which they are used in the grid included on the checklist under Length (See notes on completing the checklist for more information).

When the student appears to have finished and has not recorded anything more at B), the A should wait to be sure that the student isn't just pausing and the ask: **Have you finished?**

If the student says yes, the A should look over the student's paper and ask: **Can I see what you have found?**

The A should the read what the student has written at A) and B) (and make any notes on the checklist if needed to determine whether the student's behaviors and report of findings are consistent) and ask: **Was there anything that you thought should be kept the same to make the test fair?** If the A thinks it is necessary to follow up the question, the A then should ask: **Do you think anything else affects the results?** (The A should mark on the checklist if another variable was taken into account (e.g., the position of the clamps on the stand).

The A then should ask: **If you could do the experiment again, using the same things that you have here, would you do it in the same way or change some things that you did to make the experiment better?** The student should be given plenty of time to answer the question. If the student says that she or he would leave things the same way, the A should confirm this by asking: **Would there be anything you would change?** If the student says that changes would be made, the A should ask about those changes and confirm that they are improvements. The A should say: **How would that make the experiment better?**

Scoring of the Response Sheets

Pegboard
Grades 3,7,11

B) Score 4 pts. for a response which states that the period varies directly with the length and width makes no difference. Score 3 pts. for a response which states that period varies directly with length but makes no mention of width. Score 2 pts. for a response which states that period varies directly with length and width makes a difference. Score 1 pt. for an incorrect response. Score 0 for no response.

NAME: ______________________
CODE: ______________________
SCHOOL DISTRICT: ______________

Pegboard Behavioral Checklist

LENGTH (iv)

	Width		
	Wide	Middle	Narrow
Long			
Med			
Short			

1. Length varied ☐
   number of boards used to vary length:
   2. 9 boards ☐
   3. >= 3 boards ☐
   4. 2 boards ☐
   5. Full range considered ☐
   6. extremes only ☐
   7. adjacent only ☐

In the grid at left, record the sequence of the boards used.

WIDTH (iv)

8. Width varied ☐
   number of boards used to vary width:
   9. 9 boards ☐
   10. >= 3 boards ☐
   11. 2 boards ☐
   12. Full range considered ☐
   13. extremes only ☐
   14. adjacent only ☐
   15. random selection ☐

AMPLITUDE (iv)

16. Amplitude measured - by ruler ☐
    17. by eye ☐
    18. not measured ☐
19. Controls Amplitude - same for length test ☐
    20. same for width test ☐
    21. same for both tests ☐
22. Release method - by dropping ☐
    23. pushes hard ☐
    24. same release method for both tests ☐
    25. random method of release ☐

In the diagram at left, indicate where within the swing the student starts the movement of the board.

MEASUREMENT (dv)

26. Clock - started ☐
    27. within +- 2 secs. of release ☐

Counting

28. Counted - number of swings in set time ☐
    29. between 0-4 secs. ☐
    30. between 5-10 secs. ☐
    31. > 10 secs. ☐
    32. to the end of board movement ☐

Timing

33. Timed - one swing ☐
    34. fixed number of swings ☐
    35. 0-4 swings ☐
    36. 5-10 swings ☐
    37. 10-15 swings ☐
    38. to the end of the movement ☐

Comparison

39. Directly compares two boards ☐
    40. by eye ☐
    41. clocks to the end of board movement ☐
    42. clocks to the end of movement of both boards ☐
    43. clock stopped within +- 2 secs. of event ☐
    44. repeats comparison of boards to check ☐
    45. no apparent measurement or judgement used ☐

METHODOLOGICAL AWARENESS

46. Makes notes (however minimal) ☐
47. Awareness that other variables need to be controlled; acknowledges that aspects of the investigation could be improved - ☐

Check off all those which apply:

- Scale of experiment ☐
  (i.e. would need more apparatus; not enough time to experiment)
- Control for length of board ☐
- Control for width of board ☐
- Control for amplitude ☐
- Use of clock ☐
- Position of the clamps ☐
- Timing interval used ☐
- Method of comparing boards ☐
- Other ______________________ ☐
  (please specify)

THIRD GRADE SCORE POINT 4

M:S:HS
4:18:23
↗
* HE TIMED HOW LONG IT TOOK HIM TO ANSWER THE QUESTIONS!

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

Length makes a difference but width does not.

(4)

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

If it is long and fater than the shorter and skinnier it goes slower. And if one was taller and is just as sking it stile dosn't make a difrance.

(4)

A) USE THIS SPACE TO MAKE ANY NOTES.

The width doesn't make any diffrence the length makes a diffrence.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The width doesn't make any diffrence the smaller length goes faster.

(4)

SEVENTH GRADE   SCORE POINT 4

A) USE THIS SPACE TO MAKE ANY NOTES.

used 2 skiny and the shorter went faster
used 1 long skiny and short med. w.   swn... s MW slowed ~~faster~~
used 2 same length diff. w.   swang basicly the same
used 1 long wide and short skiny   short skiny want much faster

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The change in length realy makes a diff becaus that the object flows and swings evenly. and the width makes the object more indirectly balenced. I think that the shorter went faster and the width didnt do much.

④

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

④

If the Length is longer it will make go slower becuse longer it is the slower it will go. The width of Board makes it go faster then ther thay one becuse it wizes more then the the long Boards becuse the shorter it is the more wight it has to make it go faster.

chaing the wength of a boad makes a lot of diferece becuse of the mae wight the board will make it go faster.

the width of a boad desen not make to much of a difference only the Length make a difference.

A) USE THIS SPACE TO MAKE ANY NOTES. In the Larg section The Big & Med. go about the same way. On the yellow peg boards if you change the skill up hight they Both go the same speed. The same with the green ones.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The Length will go faster if there not fat. The length would go faster if it is long and not fat. If the wedth is fat and short it go fast, but if it is long and fat it would go slow.

④

The short bord swing faster.

The width dosen't matter.

ELEVENTH GRADE SCORE POINT 4

A) USE THIS SPACE TO MAKE ANY NOTES.

Changing width has almost no effect on speed of swing
Changing length has large effect - The longer
the board the slower and longer it swings.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

④

Changing the length of the boards changes the speed at which they swing. The shorter ones swing faster and for a shorter amount of time. Changing the width does not change the speed at which the boards swing but it does make the heavier ones swing longer.

A) USE THIS SPACE TO MAKE ANY NOTES.

	length ①	②	③
green	8.37	10.20	11.90
yellow	8.46	10.20	11.90
red	8.59	10.35	11.89

time (sec.) for 10 swings
times increase w/ length.
times stay about the same (or close enough) with width change,

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

④

As the length increases, the board swings slower. As the width increases, there is no change in the rate of the board swinging

(Con't)

A) USE THIS SPACE TO MAKE ANY NOTES.

length move at same rate

width ~~[illegible]~~ same ~~[illegible]~~ short one goes faster

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

④

The shorter the board the faster the board goes.

Width doesn't make any differance in speed

The closer the board is to the hook the faster the board goes.

THIRD GRADE SCORE POINT 3

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

③

The shorter the length of the board the faster it will swing. If you have two boards that are the same width and one board is longer, the longer board goes faster than the shorter board.

A) USE THIS SPACE TO MAKE ANY NOTES.

The long swing the best
The long one swings the longest

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

③

The long one swings the best.
The long one swings the longst.

A) USE THIS SPACE TO MAKE ANY NOTES.

The Short one is 30 cent. and 1
Inches The Long is 45 cen

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

③

It takes 2 Minuts for the big to stop and 1 Minute for the small to stop

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The difference the lengh makes is that the longer lengh the more it has to swing. Therefore, the longer lengh the slower. I think the thinker the width the faster.

2

A) USE THIS SPACE TO MAKE ANY NOTES.

Skinny ones look faster then fat ones.

Short skinny ones go faster then long " " .

Short fat ones slower then long fat ones

Short Skinny ones : faster then long fat once.

Short fat ones look faster then long skinny ones.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

Changing the lenth : I think short bonds go faster then long ones.

Changing the width : Skinny ones go faster then fat ones. I think the main difference is the weight.

2

THIRD GRADE SCORE POINT 2

A) USE THIS SPACE TO MAKE ANY NOTES.

The ~~biggest~~ green board and shortest pegboard goes fastest and stoped before the biggest. It was the same speed at three different levels

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE? ②

The shortest and the widest and middle length one were the fastest so I think that the shorter they are the faster they go and the biggest in width the faster they go. So the skinnyer the are the slower they go and the longer they are the slower they go.

2

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

When you make it longer it slows the object down, but who it is wider it speed up because of the weight.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

When it's longer it takes a longer amount of time to swing from one side to the other. Also when the width is longer it takes a shorter amount of time to go from one side to the other. The fastest would be a wide board that's short.

2

A) USE THIS SPACE TO MAKE ANY NOTES.

Wide red 20cm side wase 5 cm down = 13 swings = 14.30s
Wide yellow " " " " = 11 swings = 12.30s
Wide green 20cm side wase 5cm down = 9 swings = 9.50s
midle yellow 20 cm side waise 5 down = 6 swings = 6.30s
small yellow "
Large " " = 3 swings = 4.60s

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

2

longer it is the more swings it takes before swinging 5 cm lower so the shorter swings faster the wider it is the more swings it takes before getting to 5 cm so the wider is slower

ELEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO MAKE ANY NOTES.

wide red, 10 swings - 12.68
skinny red, " - 12.84

skinny yellow, 10 swings - 10.75
wide yellow, " - 12.34

skinny green, 10 swings - 9.13
wide green, 10 swings - 9.25

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The shorter boards swing faster and the longer boards swing slower. The wider boards stop swinging faster so they wind up going slower than the thinner boards.

2

A) USE THIS SPACE TO MAKE ANY NOTES.

Lenth Slower
Width faster

2

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The length of board makes it swing slower. The shorter the board, the faster it swings. The longer the board, the slower it swings. The width does the same. The thicker the width the faster it is. The smaller the width the slower it is. A board with the same length as another but with thicker width, swings evenly. ~~[illegible]~~. A shorter wider board swings faster than a long thin board

ELEVENTH GRADE SCORE POINT 2

(CM +)

A) USE THIS SPACE TO MAKE ANY NOTES.

yellow big faster than red big
red ~~small~~ thin faster big red
red thin " medium.
yellow med. " red med.
yellow big " red med.
wider green " med. green
wid yellow " small red

shorter length = faster
wider = faster
wider makes faster than length

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

②

The shorter the length of the board the faster it will swing. The wider the board is the faster it will swing. The shortest and widest board swings the fastest. The thinest longest board will go the slowest.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE. WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

Because when they swing the long one blocks some of the air so the little one can move faster. Because the wide one carries more weight than the skinny one.

①

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

it is narow and lighter the other is heaver and is not that easy for it to move. The wide bord is heaveir it has more power in its swings

①

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The skinny ones go faster because the longer they are the faster they go.

①

1

A) USE THIS SPACE TO MAKE ANY NOTES.

The Shorter board swings faster than the longer board. The two thin boards that are different in length swing about the same. The fat small board and the thin

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The boards that are small and thin go as fast as the boards that are short and fat. The longer fat boards go slower than the shorter fat boards. The thin long boards go as fast as the short thin boards. When a short fat board, and a long thin board are swung together the short fat board goes faster.

A) USE THIS SPACE TO MAKE ANY NOTES.

The one with most width seems to swing faster

a widder width board with longer width seems to go faster than others

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The longest board with most width goes faster than the longest skinnier board but the shorter width board goes faster than the longest width board but the middle sized width sort green board is fastest

①

A) USE THIS SPACE TO MAKE ANY NOTES.

The smaller board stop at 37:22 seconds

The smaller board stop much quicker than last time 28:43 seconds

Notice that the larger boards takes longer to stop. 141:67 seconds

This the larger board stopped a 108:26 seconds

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The difference it makes in that by changing the length it changes the speed of an object.

changing the width and comparing it with a smaller board you can see it go faster

①

A) USE THIS SPACE TO MAKE ANY NOTES.

Well the thinner ones goes faster it has less weigh. The wider one goes slower. With two wide ones the shortest one doesn't have as much as the longest one to hang. Sense the longest one has more it tends to swing slower then the shortest one

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

Changing the length there's more to swing. as to the width there's just more weigh and it takes longer for it to stop.

①

A) USE THIS SPACE TO MAKE ANY NOTES.

It seems as though the longer and somewhat narrower the board is the faster it may move

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

①

gravity pulls on it or gravity is closer to it taking the point from which it was hanging in a circuit. Also, it was close to the surface. It also helps to speed it up /

It gives it more weight for gravity to pull onto me making it slow down

(con't)

A) USE THIS SPACE TO MAKE ANY NOTES.

11 3/4 17 1/2 6, 13.

B) WHAT DIFFERENCE DOES CHANGING THE LENGTH MAKE? WHAT DIFFERENCE DOES CHANGING THE WIDTH MAKE?

The weight of the lenghth slows the speed of the board. The with of the board goes faster with more with because of the power.

①

NAME ______________________________

SCHOOL DISTRICT ____________________

CODE ______________________________

WOULD THE BOX WEIGH MOST COMPLETELY FILLED WITH MATERIAL A, OR WITH B, OR WITH C? WITH WHICH WOULD IT WEIGH THE LEAST?

YOU CAN USE ALL THE THINGS ON THE TABLE TO HELP YOU FIND THE ANSWERS.

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL ___.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL ___.

Activity Identification: Density

Grade(s): 7,11

Method of Administration: Individually Administered Investigation

Content Area: Mathematics-Geometry/Science-Physics

Apparatus required: Three blocks, labelled A, B, and C of different sizes, shapes, and densities; a large open box; spring scale, ruler, hand calculator, paper and pencil (Note: The blocks will be a rectangular solid, a cube, and a triangular block which is half a rectangular solid.)

Individually Administered Investigation- 7,11

The A hands the student the response sheet and says: **You are going to try to find the answer to a few questions. What you need to find out is explained on this page. Read it and then I'll answer any questions you may have.**

After the student finishes reading the response sheet, A says: **Do you understand what you need to find out?** (A should answer any questions other than those concerning possible approaches to the problem.) **Remember that you have to suppose that the open box could be completely filled with the material that comprises each of the blocks. You will have 15 minutes to work on this investigation which should be plenty of time.**

Observations during activity

If the student is inactive for 4 minutes the A asks: **Are you stuck?**

If the student says "no", the A should ask the student if she or he Understands the task and what has to be done. If the student is clear about what has to be done, the A asks: **Okay, why don't you try to get started?**

If the answer is "yes", the A should give the following prompt: **Note that each of the blocks is a different size and shape and made of a different kind of wood. What do you need to know about each block to decide with which kind of wood would a filled box be heaviest or the lightest? Remember you have a scale to weigh things and a ruler to measure things. Think about how you can use them to help you find the answers.**

The A should note whether the student takes any notes, however minimal. The student need not be reminded to take notes.

When the student appears to have finished and has not written anything for a 4 minute period of time, the A should wait to be sure the student is finished and then asks: **Have you finished?**

If the student says "yes", the A says: **Remember you have to put down what you found on your sheet.**

The A then should look at the student's paper and ask: **Can I see what you have done?**

The A should note whether the information recorded is consistent with those findings reported on the response sheet. If the A is in doubt of the student's approach, particularly the use of a correct or an alternative formula to compute a given measure the A should make inquiries about the student's behavior. For example, if the A is unsure how the densities of the blocks were found the A should ask: **Show me or tell me how you figured out the densities for each of the blocks. What did you do to make it possible for you to compare the materials accurately?**

If the A is unsure of which strategy the student used to determine with which material the box would weigh the most/least, the A asks: **What did you do to figure out the answers to the two questions in the box on your sheet?**

If the A is unsure whether the student considered the number of blocks that fit into the box the A should ask: **Was it necessary to figure out how many of each kind of block would fit in the box?**

Scoring of the Response Sheets

Density
Grades 7,11

B) Score 3 pts. if the student answers both questions correctly - **B** for question 1 and **C** for question 2. Score 2 pts. if the student answers one question correctly. Score 1 pt. if the student answers both questions incorrectly. Score 0 for no response.

NAME: ____________________
CODE: ____________________
SCHOOL DISTRICT: ____________

Density Behavioral Checklist

BLOCK WEIGHT	1. Weighs Blocks - Block A	☐
	2. Block B	☐
	3. Block C	☐
	4. Records weight of blocks - in grams	☐
	5. in ounces	☐
	6. inconsistently	☐
	7. Does not record weights	☐
BLOCK MEASUREMENT	8. Measures Blocks - Block A (cube) - 3 dimensions	☐
	9. 1 or 2 dimensions	☐
	10. does not measure	☐
	11. Block B (rectangular) - 3 dimensions	☐
	12. 1 or 2 dimensions	☐
	13. does not measure	☐
	14. Block C (triangular) - 2 dimensions of base and vertical height	☐
	15. 2 dimensions of base and slant height	☐
	16. 1 or 2 dimensions only	☐
	17. does not measure	☐
	18. Records measurements - in centimeters	☐
	19. in inches	☐
	20. inconsistently	☐
	21. does not record	☐
BLOCK VOLUME	22. Measures Volume - Block A - uses a correct formula	☐
	23. uses an incorrect formula	☐
	24. does not compute	☐
	25. Block B - uses a correct formula	☐
	26. uses an incorrect formula	☐
	27. does not compute	☐
	28. Block B - uses a correct formula	☐
	29. uses an incorrect formula	☐
	30. does not compute	☐
DENSITY COMPUTATION	31. Computes Density - using a correct method	☐
	32. using an incorrect method	☐
	33. estimates by "eyeballing"	☐
	34. does not compute densities directly	☐
BOX MEASUREMENT	35. Measures Box - uses 3 dimensions	☐
	36. uses 1 or 2 dimensions	☐
	37. does not measure boxes	☐
	38. Computes Volume of Box - using a correct method	☐
	39. using an incorrect method	☐
	40. does not compute	☐
	41. Number Blocks fitting in box - estimates by "eyeballing"	☐
	42. computes	☐
	43. does not consider	☐
METHODOLOGICAL AWARENESS	44. Overall approach used - computes and compares densities without using the box	☐
	45. computes volume & number of each block to fill box	☐
	46. estimates number of each block to fill box	☐
	47. uses a combination of methods	☐
	48. develops unique strategy (specify) ____________________	☐
	49. no apparent strategy	☐
	50. Determines heaviest	☐
	51. Response consistent with findings above	☐
	52. Determines lightest	☐
	53. Response consistent with findings above	☐
	54. Repeats measurement - for blocks	☐
	55. for volumes	☐
	56. for densities	☐
	57. for measurement of the box	☐
	58. for all measurements	☐
	59. does not repeat any measurements	☐
	60. Makes notes (however minimal)	☐

SEVENTH GRADE SCORE POINT 3

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

$A = 216\ in^3$ 100 grams

$B = 826\ in^3$ 100 grams

$C = 224\ in^3$ 100 grams

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

(3)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

4

MATERIAL "A" WEIGHS: 4 oz.

THE BOX WEIGHS - 7 ½ OZ.

15 boxes of "A" material would fit in the box, so the box plus 60oz. of material would weigh 67.5 oz.

B

MATERIAL "B" WEIGHS: 2.2 oz.

50 boxes of "B" material would fit in the box so the box plus 110 oz. of material would weigh 117.5 oz.

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

(3)

MATERIAL "C" WEIGHS: 3.5 oz.

14 triangles of "C" material would fit into the box plus 49 oz. of material would weigh 56.5 oz.

(Con 't)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A = $4\frac{1}{4}$ oz 100.8

B: $2\frac{1}{4}$ oz 206.8

C = $3\frac{3}{4}$ oz 86.4

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

(3)

ELEVENTH GRADE SCORE POINT 3

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A - 110 gr.
B - 65 gr.
C - 100 gr.

Box. Width - 18 cm
height $^{9.5}$ 10.25 cm
length - 405 cm
Volume of Box = w(L)(h)
= 7472.25 c.c.

A - L 6 cm
W. - 6 cm
H - 6 cm
Volume: 216 cc

C L. - 8 cm
W. - 8 cm.
H. - 8 cm
Volume: $512\left(\frac{1}{2}\right)$ = 256 cc

B L. - 7 cm
W. - 3.5 cm
H - 4 cm
vol.: 98 cc

for A: $\frac{110gr}{216cc} = \frac{3805.31}{7472.25}$

for B: $\frac{65gr}{98cc} = \frac{4956.08}{7472.25}$

for C = $\frac{100gr}{256gr}$ $\frac{2918}{7472}$

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

(3)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

C = 3ou
B = [illegible]
A = 4ou

B is the smallest could fit more

A takes up more room

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

(3)

(Con't)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

V × D = W

D = $\frac{W}{V}$

	weight	dimensions	volume	density (weight / vol.)	
cube A	115 g	6.3 × 5.8 × 6.2 cm	226.5 cm²	.5 cm/g	
rectangular B	63 g	7.1 × 3.6 × 3.8 cm	97.1 cm²	.64 cm/g	(highest)
triangular C	90 g	7.6 × 7.4 × 8.1 × (× ½) → (base) (height) (width)	227.8 cm²	.40 cm/g	(lowest)

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

③

SEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A) 4 ounces = 216 cm^2
B) 2.25 ounces = 85.75 cm^2
C) 3 ounces = 202.5 cm^2

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.
THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL A.

2

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A - 101 g
B - 51 g
C - 100 g

length - C 11 cm
A - 6 cm
B - 7cm

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL A.
THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

2

SEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A wieghs 110 grams the box is 40 inchs

B wieghs 70 grams

C wieghs 90 grams

3 A blocks width

4 A block length 24

2 A blocks hghth

A wieghs 2640 Grams

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL A.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

2

ELEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A = 4 ounces and 6.2 cm all the way around

will go into box 1.5 times.

4 ounces + 2 = 6 ounces

3.5 cm lengt

21 X 4 = 84 ou

7.2 times at 4 ounce

~~l-w-h~~

9.8 cm deep

45 cm. long

C = 3 ounces 2 of them = 6 ounce

7.4 cm 6.25 times at 3 ounces

14 X 3 42

1.5 ce

B = 2 ounces 7 cm 6.42 times at 2 ounces &

it will be more because ble is shorte

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL A.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

12 2 x 5 . 5

(2)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

$36 \times 6 = 216$

64×5

2370

square = 110 g. (3 1/2 oz.) $(6\frac{1}{8})^3 = 216\frac{1}{}$ = 276

229 × 110.

rect - 60 g. (2 oz.

$7\frac{3}{8} \times 3\frac{1}{2} \times 3\frac{3}{4} =$ 295.3

triang = 90 g.

$\frac{4}{8}$ $\frac{4}{64}$ $\frac{1}{16}$ $\frac{12}{16}$

12

12

5 × 12 60

$\frac{49}{8} \times \frac{49}{8} \times \frac{49}{8}$

2^4

2 × 5 × 2 = 20

17718

$17\frac{1}{2}$ × 40

2 × 12

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL A.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL C.

(2)

ELEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

Box weight = K

Weight of block A = 100g. 3.5 ounces 1500

B = 50g 1.7 ounces 3210

C = 100g 3.5 ounces 1640

1.7
2.2

14
15
60

160

4.2

64 2
32.10.0

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL B.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL A.

(2)

SEVENTH GRADE SCORE POINT 1

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A = 4.25 ounces
B = 2.5 ounces
C = 3.25 ounces

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL A.
THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL B.

1

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

B2.5

C3.5

0.4

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL a.
THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL B.

1

SEVENTH GRADE SCORE POINT 1

(Unit 7)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

C is largest weighs 115 g 4 ounces

A is second largest weighs 113 4 ounces

B is smallest weighs 70 g 2½ ounces

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL C.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL B.

①

ELEVENTH GRADE SCORE POINT 1

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A weighs About 100
C weighs about 101
B wieghs about 99

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL C. ①
THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL B.

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A - 110 grams 5.8cm × 6.2cm × 6.2cm 223.0 cm
C - 95 grams $\frac{1}{2}$(5.8cm × 11.7cm) × 8cm 271.4 cm^3
B - 65 grams 7.1cm × 3.5cm × 3.7cm (rounded corners) 91.9 cm^3

$8.3\overline{)34.3}$

box = 39.3 × 10.0 × 17.5 = 6877.5 cm^3

Den. A = $\frac{110}{223.0}$ $\overset{14}{.493}$ g/cm^3 Den C: $\frac{95}{271.4}$: .350 g/cm^3
Den B: $\frac{65}{91.9}$ = .707 g/cm^3

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL C. ①
THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL A.

ELEVENTH GRADE SCORE POINT 1

(Con't)

A) USE THIS SPACE TO KEEP ANY NOTES ON WHAT YOU DO AND WHAT YOU FIND OUT.

A) is 12 ounces, about 2 in width
B is 11 ounces - 1 in width
C is about 12 and ½ ounces, 4 in. width

B) FILL IN THE BLANKS TO COMPLETE THE SENTENCES BELOW:

①

THE BOX WOULD BE HEAVIEST FILLED WITH MATERIAL C.

THE BOX WOULD BE LIGHTEST FILLED WITH MATERIAL B.

The box would be heaviest with material C because it weighs more than A or B. It's width is greater also than both A and B Therefore it would be most heavy with material - C -. The box would be less heavy with material B. Because B weighs less than C or A. Therefore with a box completely filled with B would wiegh less than A or C because of its lesser consentration Material B also is less in width than A or C.

✓

NAME ______________________

SCHOOL DISTRICT ______________________

CODE ______________________

WHICH FABRIC WILL KEEP YOU WARMER IN COLD, DRY WEATHER?

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

____

____

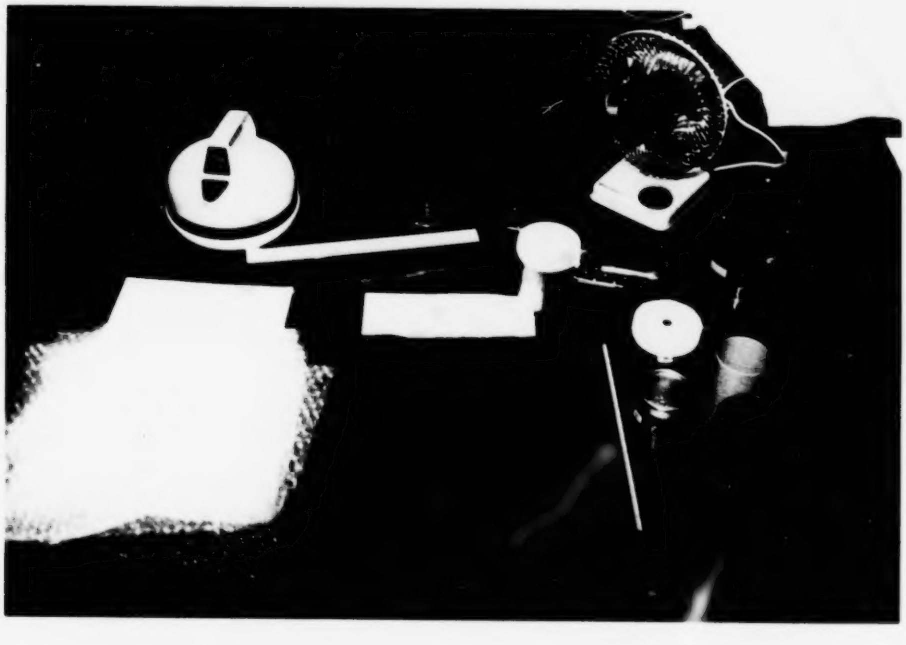
Activity Identification: Survival

Grade: 7,11

Method of Administration: Individually Administered Investigation

Content Area: Science-Physics

Apparatus required: Five cans labelled A-E (two identical aluminum cans A and B, one plastic can E with the same dimensions as A and B, one aluminum can C that is the same height as A, B, and E but of a larger diameter, one aluminum can D with the same diameter as A, B, and E but shorter height); 110°C thermometer, rubber bands, pins, transparent tape, scissors, electric kettle, two measuring cups, sheets of blanket, sheets of plastic, fan, small ruler, graph paper, cold water container with stopper, paper towels, pencils.



Individually Administered Investigation- 7,11

Imagine that you are about to take a trip on which you could be stranded on a mountainside in cold, dry, windy weather. You can choose to take one of the fabrics in front of you to help keep you warm (A points to the two materials). **What you will need to find out is** (A points to the student's response sheet):

Which fabric will keep you warmer?

I'll go through the equipment with you:

There is (A points to each piece of equipment as it is mentioned) **a kettle to heat water, a supply of cold water, rubber bands, pins, transparent tape, a ruler, a stop watch for timing things** (A allows the student to practice starting, stopping, and resetting the clock), **various cans, measuring cups, thermometers, a fan** (A allows the student to switch the fan on and off), **a roll of paper towels, and paper and pencil to record what you find.**

Let me give you a few suggestions about how you can find out which material will keep you warmer:

- **use a tin can instead of a person**
- **put hot water inside to make the can more life-like**
- **make the can a cover from the fabric**
- **use a fan to make an imitation wind**

Do you have any questions? (A addresses any questions the student has about using the equipment or about the task without addressing specific questions about how the equipment may be applied to the investigation or ways the student may approach the investigation.) **Okay, let's begin. Remember, you have to find out which fabric will keep you warmer. You may use as much fabric as you need. You will have 45 minutes to work on this investigation which should be plenty of time.**

Observations during activity

If the student has been inactive for a period of 4 minutes, the A should ask: **Are you stuck?**

If the student says "no", the A should say: Okay, continue your work. If the student says "yes", the A should say: **Just try to think about what you might do if you were in the situation described on your sheet. Just do what you think is the right thing to do to answer the question.**

After the student has appeared to finish doing work, wait for a short period of time to make sure the student isn't just pausing and then the A should ask: **Are you finished?** (If the student says "yes" the A should continue). **Can I see what you have done?**

The A then should ask: **If you could do this experiment again, using the same things that you have here, would you do it in the same way or change some things that you did to make the experiment better?** The A should give the student plenty of time to answer the question. In the answer the A should look for a critical view of what has been done rather than changes which are necessarily better.

Scoring of the response Sheets

Survival
Grades 7,11

B) Score 4 pts. for the correct answer, **plastic**, with notes. Score 3 pts. for the correct answer without notes. Score 2 pts. for an incorrect answer with notes. Score 1 pt. for an incorrect answer without notes. Score 0 for no response.

NAME: ____________________
CODE: ____________________
SCHOOL DISTRICT: ____________________

Survival Behavioral Checklist

		blanket	plastic
MATERIAL (iv)	1. Material used - blanket	☐	☐
	2. plastic		
SET-UP MATERIAL	3. Material used alone	☐	☐
	4. Material tested in water	☐	☐
	5. Material around - hand	☐	☐
	6. thermometer	☐	☐
	7. Material around can - A or B	☐	☐
	8. C	☐	☐
	9. D	☐	☐
	10. E	☐	☐
	11. cylinder	☐	☐
	12. Used material for less than 1 layers	☐	☐
	13. plus a lid	☐	☐
	14. plus a base	☐	☐
	15. Used material only as a cover	☐	☐
	16. Material fixed/held in place	☐	☐
SET-UP WATER	17. Used hot water (> 60 C) in can	☐	☐
	18. Used warm water (35 - 60 C) in can	☐	☐
	19. Used cold water (< 35 C) in can	☐	☐
	20. Water measured - by cylinder	☐	☐
	21. by ruler	☐	☐
	22. by eye	☐	☐
	23. Water not measured	☐	☐

Actual Volume used for each material:

Blanket <1/2 full	☐	Plastic <1/2 full	☐
1/2 full	☐	1/2 full	☐
3/4 full	☐	3/4 full	☐

		blanket	plastic
MEASUREMENTS (dv)	24. Baseline measure of water before starting	☐	☐
	25. Read initial temp. thermometer on outside of can	☐	☐
	26. Thermometer used correctly (in water)	☐	☐
	27. Clock used accurately (+- 5 secs. of reading temp.)	☐	☐
	28. used inaccurately	☐	☐
	29. Recorded temp. at regular intervals	☐	☐
	30. Recorded temp. at irregular intervals	☐	☐
	31. Number of temp. readings made: 2	☐	☐
	32. 3-5	☐	☐
	33. >5	☐	☐
	34. Read final temp. of water	☐	☐
	35. Read final temp. after fixed time	☐	☐
	36. Read final time after fixed temp. drop	☐	☐
	37. Time interval - < 1 minute	☐	☐
	38. 1-2 min.	☐	☐
	39. >2-5 min.	☐	☐
	40. >5-10 min.	☐	☐
	41. >10 min.	☐	☐
	42. Used fan - to cool cans	☐	☐
	43. to blow air through material alone	☐	☐
	44. to dry material	☐	☐

45. Fan used consistently for both materials ☐
46. Acknowledges that changes could be made in the procedure - aware that other variables could be controlled. ☐

Check off all those which apply:

Scale of experiment (i.e. would need more apparatus; not enough time to experiment) ☐
Use of materials ☐
Use of water ☐
Measurement of water temperature ☐
Timing interval used ☐
Use of fan ☐
Other ____________________ (please specify) ☐

CONTROLS (cv)
Can ☐ Material ☐ Temp. ☐
Volume ☐ Fastening ☐ Cooling ☐

SEVENTH GRADE SCORE POINT 4

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

Probably plastic because when I put the themomoters in different enviornments, the themometer in the plastic seemed to ~~se~~ hold more heat so the themometer in that one was ~~to~~ at a higher degree.

④

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

(x)

Blanket lets air throug threads plastic does not plastic much better for wind. Testing ~~to~~ wich Material keeps the water hotter Both are the same

Now testing to see wich material keeps cold water cold.

The plastic keeps the water cooler.

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

I found ~~out~~ that the plastic is better for wind. I think from my experiments that the plastic would be warmer.

④

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

Blanket with Fan ~~Keept~~ 2 degrees warmer with blanket

Hot water in cans with blanket 63° second 59°

without wind and plastic 1st 72½° 2nd 65° for 175 39

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

The Plastic!

④

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

Plastic fabric: original water temp. 58°C

Wind

1/2 min	56°C
1 min.	56°C
2 min.	55°C
3 min.	54°C
4 min.	53.5°C
5 min.	53°C

~~6 min. 52°C~~
~~7 min. 51.5°C~~
~~8 min. 51°C~~

total drop = 3°C

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

The plastic fabric would be 3 to 4 times warmer than the wool.

④

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

4

BLANKET
1st
27
55

PLASTIC
2nd 26
67

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

I found that the Plastic keeps the heat in the plastic and the blanket lets out some of its heat. I would take the plastic.

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

warm body) C - hot water - measured temp. 49°C timed 20 sec.
cold body) B - cold water - measured temp. 30°C timed 20 sec.
cold body) C - cold water - covered by plastic - strong wind - 25°C timed 20 sec.
cold body) C - cold water - covered by blanket - strong wind 20°C timed 20 sec.
warm body) A - hot water - covered by plastic - strong winds - 48°C timed 20 sec.
warm body) A - hot water - covered by blanket - strong winds - 44°C timed 20 sec.

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

④

1) I found that a warm body's temp. dropped 1°C when covered by plastic and strong winds were present. I also found that when the body temp. is low, being covered by plastic and strong winds being present allowed the temp. to drop 5°C.

When the body is cold, strong winds are present and covered by a blanket the body temp. drops 10°C.

When the body is warm, strong winds are present and covered by a blanket the body temp. only drops 5°C.

I have come to the conclusion from my observations and experiments that plastic will keep you warmer in cold, dry weather

SEVENTH GRADE SCORE POINT 3

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

The plastic would keep me warmer.

③

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

③

I will take the blanket because the plastic will keep you warmer but it will suffer cate you.

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

The plastic would keep you warmer because I did a experiment that if you would water on a blanket it would sink in and if you put water on plastic it wouldn't sink down it would just dry up.

③

ELEVENTH GRADE SCORE POINT 3

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

I think that plastic would keep you warmer because from my investigation, I used the boiling water to represent the persons body, the plastic held the vapor in. It also will keep the cold air out. So I think the plastic would keep you warmer.

③

SEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

hot water + fan

cons: A: Blanket 75 before/after: 63
B: Plastic 75 before/after: 58 1/2

cold water

absorbance D: Plastic : Both keep
10 sec C: Blanket dry

②

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

blanket will keep warmer

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

The wool had wind seep through, but the plastic didn't. The plastic would be warmer here. The water did not go through the wool so you would stay dry. Doesn't dry fast. wind helps it dry faster

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

②

The wool was best. 1) Because it only got wet on one side.
2) It dried fastes in cold + hot water.

SEVENTH GRADE SCORE POINT 2

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

I wraped 1 can in a blanket and the other in plastic. I filled each with water The water's temerature was about 21 °celcius, a little colder than room temperature. The temperature didn't change after 6 min so I added another layer to each can

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

in 2 out of 3 trials the blanket was warmer. the other one was the same. ②

The Blanket will keep you warmer

After another 6 min the blanket-covered can's water went up 1°C, but the plastic-covered can's water went up $\frac{1}{2}$°C, I then set up a fan equally blowing on each can for 6 min. The blanket-covered can's water went down $\frac{1}{2}$°C to $21\frac{1}{2}$° Celciuse the same temperature as the plastic covered can's water. I then heated water to 59°C and let it sit for another 6 min. The blanket covered can's water temperature was $54\frac{1}{2}$°C the plastic covered can's water was 54°C

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

In can B (hot H_2O) Plastic on top bubble-side up, kept Δ in other cans (metal) both w/hot water
1 w/ blanket
1 w/ wrap (plastic) } Δ escaped.

②

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

I found the blanket to keep you warmer. I would have thought that the plastic with the bubble side down would be the better insulator. I didn't like the way I went about solving the problem exactly. As I progressed, I thought of better testing procedures It was not due to lack of materials or time. Good question, good idea.

(Con't)

square = 150 x 150 mm

WHICH FABRIC WILL KEEP YOU WARMER IN COLD, DRY WEATHER?

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK. 50 ml of H_2O.

① A = plastic B = WOOL time = 1 minute.

50 ml

orig. temp °C : final 48° 37° — Δtemp = 11°C

orig temp : final 42° 35.7° — Δtemp = 6.3°C

50 ml w/ wind (fan) ②

② A = plastic — orig (°C) final 48° 38° — Δt = 10°C

B = wood — orig final 48° 37.5° — Δt = 10.5°C

③ A = Wool — orig final [illegible] 34.7° — Δt = 9.3

B = plastic w/ wind — orig final 44.5° 36.5 — 50 ml

$$\begin{array}{r} 44.5 \\ 36.5 \\ \hline 8.0 \end{array}$$

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

The wool will keep ~~me~~ warmer in a cold dry area.

plastic	wool
11	9.3
10.0	6.3
8.0	10.5
29.0 / 3 = 9.6	26.4 / 3 = 8.7°C (Av)

(con't)

WHICH FABRIC WILL KEEP YOU WARMER IN COLD, DRY WEATHER?

A) USE THIS SPACE TO KEEP NOTES ON YOUR WORK.

experiments

Can C = wool left for 2:00min in water at 77°C

Can D = plastic

repeated

on back

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER? ②

I found that the blanket will keep you warmer the results of my experiments are in graph form except some special observations I found that I could protect my hand when I handled the the cup with the boiling water better if I used the blanket more so than the plastic. I could also shield most of the cold air by using the blanket

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

I found out that the blanket would keep you warmer. ①

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

Blanket keeps you warmer ①

I proved this by heating water in a can. First I wrapped the blanket around the can and blew cold air on it for 30 seconds. I stuck a thermomometer in to see what the temp. was, it was around 80°.

Then I stuck plastic around the can, blew air on it & stuck thermometer in it. The temp. was lower at about 60°.

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

I think it was the Blanket becuse I put water in to cupes and a pice of Blanket on top of one and on the other I put a pice of palcstk and the Blanket was the wormest and the one in placstk was a little bit cold. ①

ELEVENTH GRADE SCORE POINT 1

B) WHAT DID YOU FIND? WHICH FABRIC WILL KEEP YOU WARMER?

by Testing The body Temperature with each of The materials That The blanket would Keep you warmeR.

①